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Study of Previous Concrete

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ABSTRACT

Water Absorbing pavement is a new technique in Pavement construction. Through this technique we can find a solution for the low ground water level, effective management of storm water runoff, Agricultural problems, etc. Pervious concrete can be introduced in low traffic volume areas, walk ways, sub base for concrete pavements, inter locking material etc. Pervious concrete as a paving material have the ability to allow water to flow through itself to recharge ground water level and minimize surface storm water runoff. This property of porous concrete reviews its applications and engineering properties, including environmental benefits, strength and durability. For porous concrete, water permeability is the main specification requirement instead of its strength and continuity of the open pores is the main concern in the production of porous concrete. The high water permeability of porous concrete makes it to be considered as an environmentally friendly concrete. When the component materials of porous concrete, environmentally unfriendly Portland cement is partially replaced by supplementary cementitious materials, such as fly ash, ground granulated blast furnace slag and coarse aggregates by recycled concrete aggregate, then the porous concrete could be considered as environmentally concrete for sustainable construction. By replacing a part of cement with conplast SP430, then it results the more strength to the concrete. Hence it acts as an eco-friendly paving material.

KEYWORDS-Water absorbing roads, Porous concrete, Permeability, Pavement, Conplast SP430

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Pervious concrete which help to absorb water and going to be future modern technique in construction. As with the help of pervious concrete we can take a security of water logging, caused accident through pits on other hand due to pervious concrete we can generate beauty of road by not collecting water on the site of the roads and help to maintain environment too. Pervious concrete properties help in recharging water table, effective movement of runoff. Pervious concrete can be used in the rural surrounding area, parking working lane, hospital working lane, which help to absorb water and does not caused any accident due to water present on the surface of the road. Pervious concrete is also known by the other name like porous concrete, permeable concrete, no fine concrete and porous pavement as all above mention concrete are the special concrete in comparison to normal concrete as it high porosity for concrete flatework applications that allow water from hydrologic cycle (precipitation) and other source to pass directly through there by reducing the runoff from a site and help full in recharging the ground. The reason behind pervious concrete absorb water is a pervious concrete have a large interconnection of voids and voids ratio help water conveyed through the surface and allowed to infiltrate. A pervious concrete can be made from a mixture of cement, course aggregates and water like normal concrete but it contain little or no sand, which make concrete in which water can pass. Pervious concrete becoming a need in a rural areas and effective means to achieve important environmental issues. It also support for keeping clean and safe environment.

Water absorbing roads: Porous pavement, or permeable pavement, is an engineered hardscaping 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.
2. Porous Asphalt.
3. Permeable Pavers.

Pervious concrete: Pervious concrete is similar to conventional concrete but manufactured without most or all of the sand in order to create voids allowing water to flow through the concrete and drain through the subgrade for filtration, ground water recharge and reduction in overall storm water runoff, says Dan Huffman, vice president of national resources for the National Ready Mixed Concrete Association (NRMCA). Pervious concrete has been in limited use in Europe for over 100 years but took hold in the United States about 30 years ago, Huffman adds.

Porous asphalt: Porous asphalt pavements with stone reservoirs are a multifunctional, low impact development technology that integrate ecological and environmental goals for a site with land development goals, reducing the net environmental impact for a project. Not only do they provide a strong pavement surface for parking, walkways, trails, and roadways, they are designed to manage and treat storm water runoff. With proper design and installation, porous asphalt pavements can provide a cost-effective solution for storm water management in an environmentally friendly way.

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 storm water to infiltrate. These spaces typically account for 5 to 15 percent of the surface area. Various types of pavers are:

(a) Permeable interlocking concrete pavers (PICP).
(b) Permeable interlocking clay brick pavers (PICBP).
(c) Concrete grid pavers (CGP).

Pervious concrete can be used in a wide range of applications, although its primary use is in pavements which are in: residential roads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope stabilization, sub-base for conventional concrete pavements etc. Pervious concrete system has advantages over impervious concrete in that it is effective in managing run-off from paved surfaces, prevent contamination in run-off water, and recharge aquifer, repelling salt water intrusion, control pollution in water seepage to ground water recharge thus, preventing storm water sewer drains, absorbs less heat than regular concrete and asphalt, reduces the need for air conditioning. Pervious concrete allows for increased site optimization because in most cases, its use should totally limit the need for detention and retention ponds, swales and other more traditional storm water management devices. By using pervious concrete, the ambient air temperature will be reduced, requiring less power to cool the building. In addition, costly storm water structures such as piping, inlets and ponds will be eliminated. Construction scheduling will also be improved as the stone recharge bed will be installed at the beginning of construction, enhancing erosion control measures and preventing rain delays due to harsh site conditions.

1.2 PROBLEM STATEMENT

The road or the pavements are the essentials for the country's growth as they provides door to door service of goods and materials. The methods of construction of roads are mutated from one century to another. In the traditional road construction, we have faced so many problems like surface water flooding, poor water quality, high maintenance cost, reduced ground water levels, increased risk of contamination. For over 300 years now, Mumbai has been receiving heavy rains and also witnessing high tides. The amount of rain that the city receives has remained the same. So, what has changed? Why does it now submerge the city after every spell? Rapid urbanisation, which turned Mumbai into a concrete jungle, is one of the key reasons.

Why can't we use roads that absorb water in India?

Yes, they are used in India. Porous pavements were designed to drain the water and reduce splashing of water at the road while at the same time having sound absorbing property. These pavements are based on open graded friction course which contain very high air voids and therefore lacks strength. Hence, these roads find very limited application in our country and are generally used in parking spaces, bus stations and low volume roads.

1.3 HISTORY OF WATER ABSORBING ROADS IN INDIA & WORLD

Within the UK in 1852, the primary use of permeable concrete was with the growth of two homes that are residential and an ocean barrier. Price potency appears to possess the first motive for its original practice because of the restricted cement quantity used. Absolutely, it was not until 1923 once permeable concrete resurfaced as a feasible structure material. Now it absolutely was restricted to the development of two storey households in areas like European country, London, Liverpool and Manchester. Porous concrete usage in Europe redoubled steady, particularly within the war II generation. As permeable concrete utilize fewer cement than typical concrete for cement was scarce at this point. It appeared that porous concrete was the simplest suites material for that amount. Thus, it gained continued quality and it unfold to areas like West Africa, Australia, Venezuela, Russia and the geographical region.

GHMC Water-absorbing road technology in Hyderabad-

Cost: GHMC PAYS Rs 50 lakh per km of concrete road, 'pervious tech' will cost Rs 60 lakh in India. In the Netherlands, the roads are constructed with material that absorbs rainwater, which allows for recharging of groundwater. In Hyderabad, after a single downpour there is water logging on roads but no change in groundwater levels. The cost per kilometre is almost the same. Several areas, like Habsiguda, have been declared dry as there is zero groundwater. Experts hold GHMC responsible for not applying such techniques or working on water harvesting pits. Prof. N.V. Ramana Rao of JNTU's civil engineering department said, "This technology is called 'pervious concrete roads' in which there are open pores on the road surface. Whenever it rains, the road absorbs water and this recharges the groundwater level. Indian roads are normally made of solid blocks. The pervious concrete road technology is currently used in Delhi. Some apartments and gated communities have laid these roads."

"Pervious roads are also designed to take the traffic load. It is a mixture of 'aggregate' – small broken pieces of stone and a special grade of cement —when water flows on it, it gets absorbed into the ground below. Foreign nations spend around $80,000 (about Rs 54 lakh) on one km of this road. "In India, going by present calculations, it will cost around Rs 60 lakh per km of pervious concrete road," said Mr Rao.

"There are two advantages with this technology. Rainwater is absorbed into the ground. So roads do not break down and have a longer life. Rainwater directly seeps through the pores in the road and joins the groundwater, slowly resulting in the rise of groundwater levels," said Prof. G.K. Viswanadh of civil engineering at JNTUH.

A senior engineer from GHMC said, "The amount spent on 1 km of road is Rs 10 lakh to Rs 50 lakh keeping in mind the past condition of the roads. In case of a concrete cement road, almost Rs 50 lakh is spent per km. "While experts suggest alternative ways, the GHMC in association with residents' welfare associations should encourage people to lay pervious concrete roads within colonies on partnership bases, with 70 per cent of the cost paid by GHMC. Secondly, it should construct rainwater harvesting pits free of cost in every colony."

1.4 ENVIRONMENTAL BENEFITS

- Native formation recharge.
- Pollution removal and water budget retention.
- Fewer would like for storm drain.
- Green edifice different appropriate for several applications.
- Normal run-off permits rain to empty on to sub surface.
- Decreased edifice needs for voidance buildings.
- Reduce contamination avoids conservational harm.
- Defends lakes and streams and permits native foliage to flourish.

1.5 AIM AND OBJECTIVES OF THE PROJECT

1.5.1 AIM

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.

1.5.2 OBJECTIVES

- To study of porous pavement.
- The main objective is to investigate the performance characteristics of the pervious concrete such as porosity, compressive strength, infiltration rate etc.
- Planning and designing of porous pavement.
- Environmental consideration of porous Asphalt.
- Development of permeable pavement.
- Estimating the in-situ compressive strength, uniformity, quality and homogeneity.

2. LITERATURE REVIEW

Research Summary-1

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 ground water 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 liters per minute per square meter). Typically, pervious concrete has little or no fine aggregate and has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids.

Research Summary-2

Lucas NiehunsAntunes, EnedirGhisi and LiseanePadilhaThives (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.

Research Summary-3

Reshma K. J. , Keerthi K. ,Vidhyashree H. P. , Shabnam K. R. , Deekshitha and Kiran Raj Shetty: Challenges in Implementation of Porous Asphalt Concrete in Barmanna Layout, Nelamangala Bangalore Rural District. Bangalore which is also known as the Silicon City of India has faced a heavy rain fall of 1666mm in October, 2017 breaking the earlier record of 1606mm in 2005. Roads were inundated, all the vehicles were submerged and even found floating. The increased rain fall 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 project mainly focused on Nelamangala to implement porous asphalt pavements. A survey was conducted in Barmanna Layout and identified that poor roads conditions was the most important problem. The data was collected through survey and identified that about 57% of the respondent were in the opinion that poor road condition has increased the accidents and number of potholes. For the identified problems porous asphalt pavement can be a solution which helps in overcoming these problems and cost analysis of asphalt pavement was done. It was concluded that porous asphalt pavement can reduce accidents, potholes and heavy traffic.

Research Summary-4

In this paper he summed up writing on development study and utilization of development of pavement which must be pervious under surface. He talked about issue associated with shortage of water showing up because of expanding zone of level surface has been thought of. As JeetYadu essentially centered on point by point concentrate about Raipur City and perspectives are engaged inside the course pH preservation through improving the ground water energize. It likewise manages the favorable circumstances and disadvantages of this pavement framework. Permeable asphalt convey numerous points of interest like spring water recharging, storm water the board and utilization of pervious concrete pavement is relies upon different perspectives like burden, atmosphere and traffic volume.

Research Summary-5

In this paper they sum up writing on pavements, examine on permeable pavements and suggest future zone of innovative work. It have a base and sub – base which grant the development of rain water through the surface and decrease runoff, channels toxins from the water. Release quality by sifting contamination inside the deduct layers and increment subsurface water level. They utilization of commercial squander debris in development by fractional substitution of concrete.

3. PROPOSED METHODOLOGY

Experimental Setup-

A laboratory study evaluating strength and infiltration, concrete mix was performed. The experiments included compressive strength tests, infiltration rate test on clean specimens. For experimentation M-25, M-30 and M-35 controlled concrete using locally available building materials and OPC-53 grade cement is used with suitable dose of admixture (conplast SP430). Grade 53 OPC cement was used with aggregate size retain on the 4.75mm sieve and passing through 10 mm seive. A steel tamping rod with 16mm diameter and 0.6m length and having bullet ends was used for compacting the concrete. The fine fractions in the concrete is reduced from 5%, 10%, 15%, 20% for that fine fractions of 4 cubes are prepares (1 fine fraction >2 cubes, for 0% fines by reducing the cement content to in the actual) Mix designing of M-25, M-30 and M-35 controlled concrete is done and results are validated by casting 4 cube samples (150cm×150cm×150cm) and subsequently testing infiltration rate and compressive strength after 7 days, 14 days and 28 days.

3.1 MIX DESIGN OF PREVIOUS CONCRETE

3.1.1 Void Content

At a void content lower than 15%, there is no significant percolation through the concrete due to insufficient interconnectivity between the voids to allow for rapid percolation. So, concrete mixtures are typically designed for 20% void content in order to attain sufficient strength and infiltration rate.

3.1.2 Water – Cement Ratio

The water-cementitious material ratio (w/cm) is an important consideration for obtaining desired strength and void structure in pervious concrete. A high w/cm reduces the adhesion of the paste to the aggregate and causes the paste to flow and fill the voids even when lightly compacted. A low w/cm will prevent good mixing and tend to cause balling in the mixer, prevent an even distribution of cement paste, and therefore reduce the ultimate strength and durability of the concrete. w/cm in the range of 0.26 to 0.40 provides the best aggregate coating and paste stability. The conventional w/cm-versus-compressive strength relationship for normal concrete does not apply to pervious concrete. Careful control of aggregate moisture and w/cm is important to produce consistent pervious concrete.

3.1.3 Cement Content

The total cementitious material content of a pervious concrete mixture is important for the development of compressive strength and void structure. An insufficient cementitious content can result in reduced paste coating of the aggregate and reduced compressive strength. The optimum cementitious material content is strongly dependent on aggregate size and gradation but is typically between 267 and 415 kg/m3. The above guidelines can be used to develop trial batches. ASTM C1688 provides the tests to be conducted in the laboratory to observe if the target void contents are attained.

3.2 PREPARATION OF CUBE SPECIMENS

The method of compression strength of concrete cubes:

- The cube moulds are made for specimen size 15 x 15 x 15 cm.
- The metal moulds can be assembled and taken apart by bolting or unbolting.
- The concrete is hand compacted and then machine compacted.
- The specimens are covered with wet gunny bags for 24 hours and the immersed in curing tank containing fresh, clean water.
- These are kept in water for 7, 14 and 28 days and then taken out and tested under compression testing machine.
- The failure load divided by cross sectional area, i.e. 225 cm^2gives the ultimate compression strength of the cubes.
- Two cubes each of 7, 14 and 28 days curing are tested and can give a good idea about the rate of increase of strength.
- Pozzolana Portland cement concrete shows about 70% strength gain in the first 7 days and remaining gain in the days thereafter.

- Thus from the 7, 14 and 28 days tests the pattern of strength acquiring can be studied and we modified that if needed.
- The co-relation of test result is done by testing on 3 specimens at each curing period.
- We compute the durability, impermeability and other characteristics from the test results.

CASTING AND COMPACTION:

- For casting, all the moulds were cleaned and oiled properly. These were securely tightened to correct dimensions before casting. Care was taken that there is no gaps left from where there is any possibility of leakage out of slurry. The fresh concrete was filled in the moulds with the help of trowel. The care was taken in to fill all moulds simultaneously to avoid segregation and to maintain uniformity. The moulds were filled and placed on the vibrating table and vibrated. As needed, concrete was added and vibrations were stopped as soon as the cement slurry appeared on the top surface of mould.
- The present experimental study of previous concret includes testing of specimens for Compressive strength. For testing of Compressive strength 150mm x 150mm x 150mm metallic mould was used, for the casting of concrete cube specimen, for testing of concrete 150mm x 150mm x 150mm cube mould was used.
- Casting of concrete cubes, beams were done as per IS code recommendations (IS Code 10262: 2009, Concrete Mix Design). The proportioning of concrete mixes consists of determination of the quantities of respective ingredients necessary to produce concrete having adequate, but not excessive, workability and strength for the particular loading and durability for the exposure to which it will be subjected.

3.2.1 Mixing

- Mix the cement and coarse aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform colour
- Add the Conplast SP430 in water and stir properly and poar into cement and coarse aggregate mixture.
- Mix it until the concrete appears to be homogeneous and of the desired consistency.

[Fig.3.1: Sampling of Coarse aggregate]

[Fig.3.2: Sieve Analysis of Coarse Aggregate]

[Fig.3.3: Admixture- Conplast SP430]

[Fig.3.4: Mixing of Previous Concrete Ingredients]

[Fig.3.5: Adding of Conplast SP430 and Water to Previous Concrete Ingredients]

3.2.2 Sampling

- Clean the mounds and apply grease.
- Fill the concrete in the moulds in 3 equal layers
- Compact each layer with not less than 35strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at lower end)
- Level the top surface and smoothen it with a trowel

[Fig.3.6: Previous Concrete]

[Fig.3.7: Compaction of pervious concrete with tamping rod]

[Fig.3.8: Cube specimens fill with previous concrete]

3.2.3 Curing of the specimens

The test specimens are stored in moist air for 24hours and after this period the specimens are marked and removed from the moulds and kept submerged in clear fresh water until taken out prior to test.

[Fig.3.9: Curing of the specimens]

3.3 TESTING

3.3.1 Infiltration test

Infiltration test was carried out with reference of the test procedure given in ASTM C1701. Infiltration test was used for finding the water passing ability of pervious concrete panel which was casted and placed in field. Infiltration test has been carried out manually. The test consists of four main components: Installing the infiltration ring, prewetting the concrete, testing the concrete and calculating the results. For infiltration rate test of pervious concrete panel of 150mm x 150mm x 150mm were casted. The ring is then placed on the cleaned surface and secured in place with plumber's putty. Then water is poured onto the surface and measuring the time for the free water to disperse. With the help of measured volume of water, time required for draining out all the water and cross sectional area of cube Infiltration rate of Pervious Concrete is found out. In this experiment study infiltration rate carried out on panel with mud operation and without it.

[Fig.3.10: Infiltration test for previous concrete]

[Fig.3.11: Percolation of water through pervious concrete]

3.3.2 Compression testing machine

Generally the compressive strength of the pervious concrete is less the conventionalconcrete to justify the various compressive strength of cube with different fine fractions this test is conducted. Compressive strength is the resistance of a material to breaking under compression.

- Remove the specimen from water after 7 days curing time and wipe out excess water from the surface
- Clean the bearing surface of the testing machine.
- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually without shock and continuously at the rate of 140 kg/cm² /minute till the specimen fails.
- Record the maximum load and note any unusual features in the type of failure.

[Fig.3.12: Experimental Setup of concrete Cube]

4. RESULTS AND DISCUSSIONS

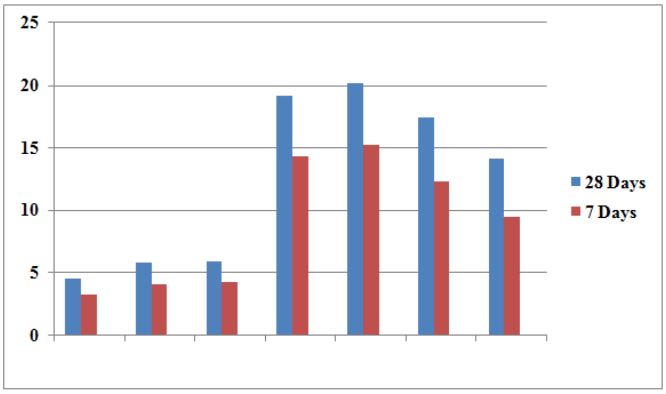
4.1 COMPRESSIVE STRENGTH TEST RESULTS

Table 4.1: Compressive strength test results

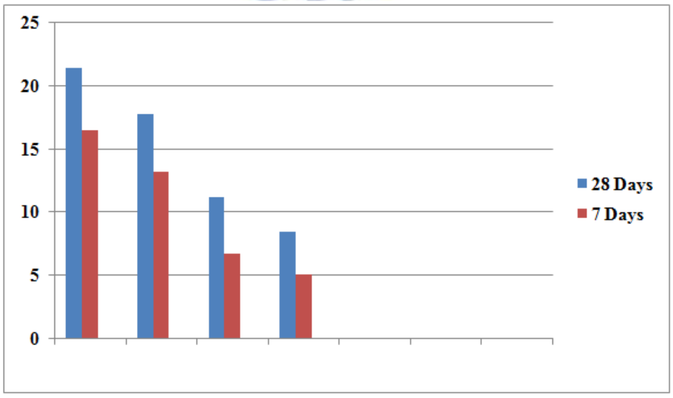
S.No.	Proportion (Cement: Aggregates)	Water/ Cement ratio	Compressive strength at 7 days (MPa)	Compressive strength at 28 days (MPa)
1.	1:5.8	0.43	3.2	4.5
2.	1:5.53	0.42	4	5.8
3.	1:5.46	0.40	4.2	5.9
4.	1:4.41	0.40	14.36	19.2
5.	1:4.41	0.38	15.22	20.2
6.	1:4.41	0.36	12.3	17.5
7.	1:4.41	0.34	9.5	14.2

Table 4.2: Compressive strength at 7 and 28 days with fly ash

S.No.	Proportion (Cement: Aggregates)	Water / Cement ratio	Percentage of cement replaced with fly ash	Compressive strength at 7 days (MPa)	Compressive strength at 28 days (MPa)
1	1:4.41	0.38	20	16.52	21.4
2	1:4.41	0.38	40	13.20	17.4
3	1:4.41	0.38	60	6.66	11.2
4	1:4.41	0.38	80	5.02	8.4
5	1:4.41	0.38	100	Not workable	–



[Fig.4.1: Effect of w/c ratio on compressive strength without fly ash]



[Fig.4.2: Effect of w/c ratio on compressive strength with fly ash]

5. CONCLUSION

From the experimental results of investigation, Porous concrete allows water passes through it. It is not composed of fine aggregates. Aggregate having size more than 20mm cannot be used, because of larger voids cause settle down of cement slurry. And aggregates having size less than 10mm can give better results. Effective utilization of waste product (fly ash),and making it as a eco-friendly concrete. Lesser percentage of fly ash gives high strength than higher percentage. Higher percentage of fly ash weaker in cement bonding.Conplast Sp430 is good admixture, and it increases the strength and bonding between cement and aggregates.

FUTURE SCOPE

- In the past due to the scarcity of cement, the pervious concrete has been used extensively.
- The pervious concrete has lost its importance after successful production of cement in large quantities.
- But now-a-days, the usage pervious concrete has gained its popularity due to many advantages.
- By using the pervious concrete we can able to recharge the ground water table and the storm water disposal can also be done.
- So, in future to tackle aforesaid problems and to protect people from flood prone areas, the pervious concrete is one effective solution.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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