Department of Civil Engineering
College of Engineering Trivandrum

EDIFICE

CIVIL MAGAZINE

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"Scientists dream about doing great things,

Engineers do them"

ABOUT THE DEPARTMENT

The Department of Civil Engineering was established along with the inception of College of Engineering Trivandrum in 1939. Department has achieved manifold progress in various domains over the years and has acquired a legacy of its own. Presently, the Department offers an Undergraduate programme of intake 120 in Civil Engineering leading to the B.Tech degree and six Post- graduate programmes, leading to the M.Tech degree of APJ Abdul Kalam Technological University. Various streams of Post graduate programme include Structural Engineering, Geotechnical Engineering, Hydraulics Engineering, Geo Informatics, Traffic and Transportation Engineering and Environmental Engineering with a total intake of 108. Moreover, as the Institute is a QIP centre of the AICTE, there are 38 scholars pursuing research leading to Ph. D in Civil Engineering.

EDITORIAL

First the assortment this time around.

For long dubbed an advocate of low cost abodes, Laurie Baker has slowly (ever so slowly), dawned to us, a prophet of sustainability. Probably, long before the term was in currency, surely much before it became fashionable. In our infinite wisdom we failed to notice the substance of his ideas. Like many prophets, tolerated but never complied to… their voices indistinct, now haunting us from the mists of time, while we flail about our little arms in desperation…..

Self-healing concrete heals cracks in structures-like a surgeon the bones. It works through the additives added- microfiber, polymers……even bacteria. Pro-biotic, if you will.

Metro without doubt, is the cleanest transit at present. One that does not add to the hustle of rail and road. We in the state, have regrettably woken a bit late to this mode of conveyance, by almost a century!!!!... ... We better remain awake…

Hyperloop is more in the theoretical realm, the manifestation of our psychedelic sci-fi dreams. This is cutting edge technology stuff, the transportation utopia, where distance is an antiquated notion. Only destination matters…..

Transforming by modern alchemy, environment No Nos like fly ash into usable improvement material are quite the norm now. That is better than allowing this potent brew of toxic metals to disseminate through the ecotones. Think of them now as performance enhancers of sorts. Quite the same way, geosynthetics act as the stabilising component in road construction (amongst others), their continued use, a testimonial to their efficacy. The concern is the lack of biodegradability and more recently, the microplastic dimension. At least they would be safely sequestered away than being recycled into more lethal forms.

Oops….so much for the articles in the issue. You would not want us to let out more about the stories, would you???

The single thread that runs through all the stories is the urge to be eco-friendly, be those practices or alternatives. Could it be our survival instincts, urging us, sustaining us, as they did so far, since the evolution of our species into a frigid unforgiving world, long back? We seem to be in a hurry to prove our green credentials!!! Aren't we a tad late to the party? With seas constantly and ever boldly nipping our shores and our planet getting greyer and hotter, probably the die has already been cast. However as the old adage runs- better late than never…..what else….???

Thank you for reading ***Edifice***.

-Editorial Team

CONTENTS

CONSTRUCTION OF METRO STATIONS

Immanuvel Rajan

B. Tech

ELEVATED CORRIDOR VIADUCT

Viaduct runs between the stations in the elevated portion of the phase 1 extension, sequence of construction are as follows:

- Construction of pile foundation,
- Construction of pile cap over pile group,
- Construction of pier over pile cap
- Erection and connection of precast pier cap with pier
- Erection of girders
- Casting of deck slab and connection of precast parapet walls (only for I-girders)

I-girders are provided over 4 spans at entry and exit of Tollgate station to provide turnout between up-track and down-track for enabling metro train to transfer between both tracks. I-girders have not been provided in the Gowriashram-Thiruvottiyur-Wimco Nagar stretch due to its proximity to the Wimco Nagar depot where switching between tracks can be done. Depot access has been provided with I-girder and deck slab.

Elevated Corridor Viaduct

PILE FOUNDATION

It is a type of deep foundation. They are formed by long slender columnar elements typically made from steel or reinforced concrete. A foundation is described as ‘piled’ when its depth is more than three times its breadth. Piles should be installed at the locations accurately as per the drawings. For getting the correctness of the point, right angle triangle method is adopted at the site.

- Drilling mud (bentonite) shall be used for the stabilization of pile bore sides in addition to temporary casing in places where there is a chance of collapse of walls of the bore holes, mud flow etc. This solution arrests the movement of soil.
- Specified termination is achieved.
- The length of the pile is 28-35 m and its

- Boring ring is too positioned in such a way that the central line of the auger is exactly over the central line of the pile marked on the ground. This can be assured by bringing the tip of the auger up to the pile point marked on the ground.

- Rotary drilling shall be done up to 3 to 4 meters depth using 1200 dia auger and the temporary casing of 3-4mts installed.

- Diameter is 1.2 m.
- Grade of concrete is 35MPa.

PILE CAP

A pile cap is a thick concrete mat rests on the concrete or timber piles that have been driven into the soft or unstable grounds to provide a stable foundation

A pile cap laying work

PILE HEAD CHIPPING:

After completion of excavation of foundation Chipping/breaking of the pile head shall be done by pneumatic chipping machine after 7 days. Chipping shall be done upto cut off level of the pile.

PILE CAP PCC:

Prior to start of PCC bottom level of PCC shall be checked and final level shall be well dressed, removed all loose soil debris and compacted by hand hammer.

REINFORCEMENT:

All the reinforcement used shall conform to IS 1786 grade Fe500D. The bars can be stacked on wooden sleepers. The bars shall be stacked in lot and dia-wise at yard. All the reinforcement bars should be coated with anti-corrosion coating.

PIER

1. Fabrication of pier reinforcement and coating of reinforcement bars with anticorrosive material.
2. Suitable staging arrangement and scaffolding must be provided for ease of fixing rebar, the rebars should be manually fixed and only a maximum of 50 percent rebar's shall be lapped at one location in lapping zone. Cover blocks of same grade as pier concrete M50 grade and size of 75mm clear cover shall be provided.
3. Temporary Staging with cup-lock system will be erected around the pier cage over firm ground i.e. over pile cap. Working platform access will be made in temporary staging by making steps at suitable interval to provide easy access to the height.
4. Drainage shall be provided as per issued GFC drawing. HDPE DWC drain pipe will be fixed manually at pier centre as per drawing with bottom invert T-joint in slope by lowering the pipe inside the pier cage. The pipe shall be secured at location by using rebar of 16mm diameter as holders. All the joints of drainage pipe shall be properly glued and packed to avoid chocking slurry during concreting.

5. Pier reinforcement shall be tied to the full height at cross arm bottom level and secured before shuttering operation. The arrangement of shuttering shall be followed as per design arrangement.

6. A hose pipe/stationary pump of 200mm diameter shall be installed up to a depth of 250- 300 mm above the starter top. Proper vibrations shall be done with the help of needle vibrator of 40/60 dia. Needle vibrator from bottom of pier formwork to top in a staggered manner to ensure effective compaction of concrete. The concrete shall be placed with the help of either stationery concrete pump or boom placer.

7. Pier Concreting shall be preferably carried out as a single pour in suitable intervals. Pouring shall be slow as desired to maintain stability of formwork due to jerk. The Concrete shall be transported by transit mixers. Slump of pouring concrete shall be maintained for pumpable concrete. i.e. 150 + or - 25 mm.

8. Height of free fall of concrete shall be restricted to less than2m.

9. De-shuttering must be done after 15-20 hours of concrete casting.

10. After concreting, care shall be taken to start the curing before the top surface starts drying. After removal of the side shutters the same shall be covered with Hessian cloth on the sides during the complete time of curing. Curing of both top and side surfaces shall be started by sprinkling water at regular intervals to maintain dampness of the hessian cloth throughout the curing period. Continuous curing shall be maintained on concrete for a minimum period of 14 days.

To Be Continued...

FLY ASH IN SOIL IMPROVEMENT

Akshay Ranjith

B.Tech

Soil is the basic foundation for any civil engineering structures. It is required to bear the loads without failure. In some places, soil may be weak which cannot resist the oncoming loads. Also, to sustain both static and dynamic load, pavements should be designed and constructed with utmost care. The performance of the pavement depends on the quality of materials used in road construction. If the stability of local soils is not adequate for supporting the loads, suitable methods to enhance the properties of soil need to be adopted. Soil stabilization is one such method. Stabilizing the sub grade with an appropriate chemical stabilizer increases sub grade stiffness and reduces expansion tendencies, it performs as a foundation.

Soil stabilization is the alteration of soil properties to improve the engineering performance of soils. The properties most often altered are density, water content, plasticity and strength. Modification of soil properties is the temporary enhancement of sub grade stability to expedite construction. Class C fly ash and Class F-lime product blends can be used in numerous geotechnical applications common with highway construction such as enhancing strength properties, stabilizing embankments, controlling shrink swell properties of expansive

soils, drying agent to reduce soil moisture contents to permit compaction. Class C fly ash can be used as a stand-alone material because of its self-cementitious properties. Class F fly ash can be used in soil stabilization applications with the addition of a cementitious agent like lime, lime kiln dust, cement kiln dust (CKD) and cement.

Fly ash has been used successfully in many projects to improve the strength characteristics of soils. Fly ash can be used to stabilize bases or sub grades, to stabilize backfill to reduce lateral earth pressures and to stabilize embankments to improve slope stability. Typical stabilized soil depths are 15 to 46 centimetres (6 to 18 inches). The primary reason fly ash is used in soil stabilization applications is to improve the compressive and shearing strength of soil.

Many clay soils (plastic soils) undergo extensive volumetric changes when subjected to fluctuating moisture contents. These volumetric changes if not controlled can lead to movements in structures and impose loads which can cause premature failure. The plasticity of soils has historically been quantified by the plasticity index, as determined by ASTM D 4318. Typically, specifications limit the plasticity index of a soil to no more than 10-12 to ensure a stable material. In general terms, the higher the plasticity index, the higher the potential to shrink or swell as the soil undergoes moisture content fluctuations. Fly ash reduces the potential of a plastic soil to undergo volumetric expansion by a physical cementing mechanism, which cannot be evaluated by the plasticity index. Fly ash controls shrink-swell by

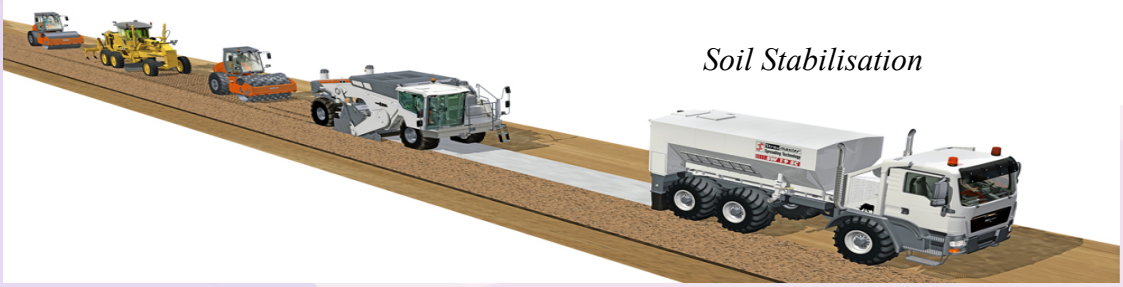
M*ixing and shaping of fly ash stabilised soil*

cementing the soil grains together much like the portland cement bonds aggregates together to make concrete. By bonding the soil grains together,

soil particle movements are restricted. Typical addition rates based on dry swell potential of fly ash treated soils is typically less than 0.5 percent under confining pressures of 48 kPa even when compacted two to four percent below optimum moisture content for maximum density.

Soils must be compacted to their maximum practical density to provide a firm base for overlying structures. For soils to be compacted the moisture content must be controlled because of the relationship between soil density and moisture content. If a soil is too wet, the moisture content of the soil must be lowered. Class C fly ash and other high lime fly ash have been found to be very effective drying agents, capable of reducing soil moisture content by 30 percent or more. The fly ash dries the soil by two basic mechanisms, chemical reactions that consume moisture in the soil and by simple dilution. Class C fly ashes contain tricalcium aluminate which is highly reactive with water. The tricalcium aluminate present in fly ash reacts with the water, lowering the overall moisture content of the soil. The drying effect of fly ash in wet soil is very rapid and immediate, permitting the contractor to quickly proceed with construction. In addition to the speeding up of the construction process the use of fly ash provides several other benefits, such as making the soil more resistant to additional water infiltration, provides additional support for traffic, creates a more stable work platform and reduces dusting from construction traffic.

Fly ash as an additive decreases the swelling and increases the strength of soil. Thus, fly ash as an additive could be used for improving the engineering properties of expansive soil. Fly ash along with another additive like lime, murrum, cement, and other such materials can be used together, and may be varied in quantity to obtain the best possible stabilizing mixture.



Soil Stabilisation

SELF-HEALING CONCRETE

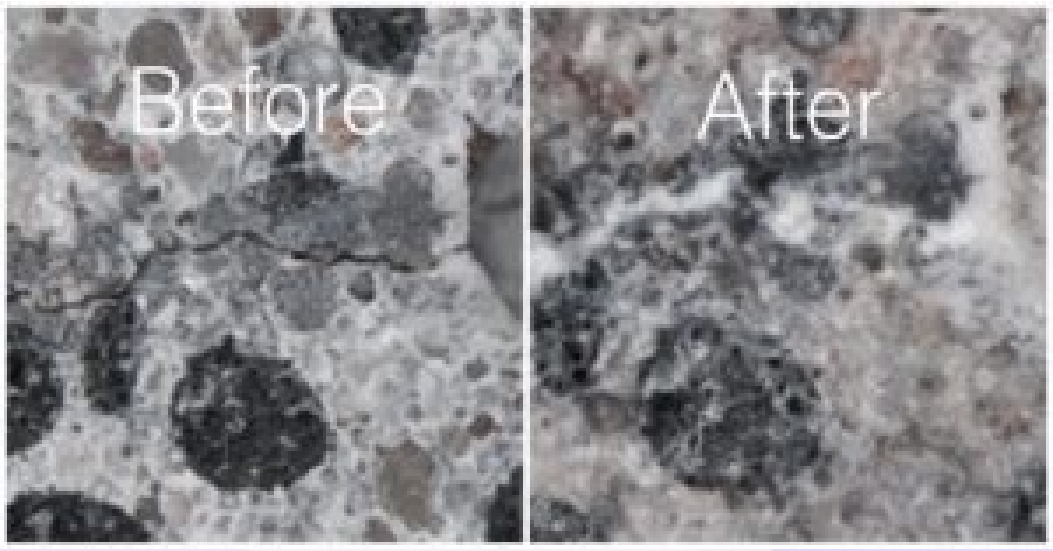
Arjun M G,

B. Tech

Concrete, the main constituent of most of the buildings, bridges etc. we see today is a substance that has high compressive strength but poor tensile strength and so, structures made of concrete are susceptible to the formation of cracks. When these micro cracks grow and reach the reinforcement, any exposure to moisture can corrode the reinforcement and eventually cause collapse.

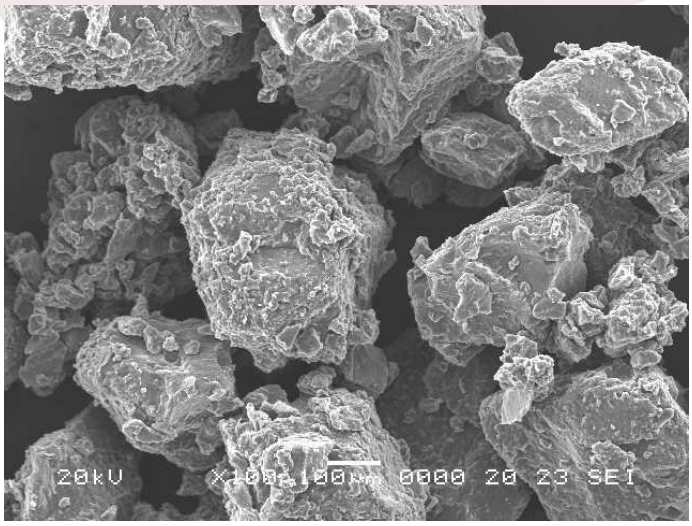
But what if concrete could heal itself? It will drastically reduce the repair costs and might possibly increase the life of the structure to a great extent. This was the idea from which the concept of a self-healing variety of concrete was formed.

Self healing concrete, as the name suggests is something that can practically heal itself in the event of a crack. There are many ways by which this can be realized, the most common being the self healing concrete made by incorporating bacteria into the concrete mix. Traditional concrete has a self healing capacity as there is un-hydrated cement present in matrix. When water contacts the un-hydrated cement, further hydration occurs. Furthermore the dissolved CO_2 reacts with Ca^{2+} to form $CaCO_3$ crystals. However this can heal only minor cracks. To enhance it, self -healing micro fibers may be incorporated into cement which practically converts a normal crack into several small cracks which can be easily replenished.



Self healing concrete mechanism

In 1887 Ferdinand Cohn claimed that with a bacterium called Genus Bacillus concrete could be healed. Genus Bacillus contains an outer layer of thick wall which can resist sunlight and chemicals. The spores are mixed with fine aggregate, coarse aggregate and cement. It results in self healing concrete. But while mixing care is taken so that cement and bacteria are not mixed together which is made sure with the help of clay pellets. In this concrete if cracks are formed, the spores which come in contact with air will reproduce to form large no of bacteria which will lead to the formation of lime as a byproduct. This will fill the cracks and eventually seal it.



Bacillus

Specially selected type of Genus Bacillus along with a calcium based nutrient known as calcium lactate and nitrogen and phosphorous are added to concrete when it is mixed.

An innovation like this which has practically limitless applications is still used only rarely. Money may not run all things but the price is also a strong contributor to the success of a project. The problem with this product is that it is very costly. Active ureo-lytic bacterial spores are still too costly for practical applications. In current the economic environment, striving for 2 Euro per kilogram dry weight is goal (as opposed to the current rate of over 40 Euro per kilogram). The major flaw here is that the encapsulation process of spores is not achieved by inexpensive methods.

Although it may not look like much, I think of this self-healing concrete as a first step towards something much more magnificent than just buildings that are crack-proof.

GEOSYNTHETICS IN ROAD CONSTRUCTION

Meenu Prasad

B.Tech

Geosynthetics are an established family of geomaterials used in a wide variety of civil engineering applications. Many polymers (plastics) common to everyday life are found in geosynthetics. The most common are polyolefins and polyester; although rubber, fiberglass, and natural materials are sometimes used. Geosynthetics may be used to function as a separator, filter, planar drain, reinforcement, cushion/protection, and/or as a liquid and gas barrier.

Eight main product categories included are: geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites . The polymeric nature of the products makes them suitable for use in the ground where high levels of durability are required. They can also be used in exposed applications.

Benefits of geosynthetics in road construction

In the present world, infrastructural projects are booming at a very fast pace. For the speedy and safer execution of such projects like construction of roads and highways, vertical civil structures, there is a huge demand of geosynthetics. One of the most common uses, however, is in road construction, particularly temporary roads such as construction roads, access roads and forest paths.

The benefits of using geosynthetics are:

Bearing capacity

For constructing both roads and parking lots, it's important subgrade is stable with sufficient bearing capacity. By using geogrids between the subsoil and base course, bearing capacity is increased. The interlocking of the cover soil with the geogrid provides horizontal force transfer, which serves to increase bearing capacity and, in many cases,allow for base course thickness to be reduced. This method also makes expensive soil exchange unnecessary.

Rutting

One of the primary concerns when building unpaved roads on soft subsoil is rutting and inter-mixing of cover material into the subsoil. By improving load distribution, geogrids serve to minimize both rutting and soil intermixing. A specific project's requirements will dictate the specifications of the geogrid needed.

Force-elongation

Low elongation characteristics of a geogrid are needed for a successful reinforcement application. In many projects, force absorption at elongation requires a product with between 2-percent and 5-percent capacity. For more demanding applications, products with up to 8-percent elongation at break are available.

Installation robustness

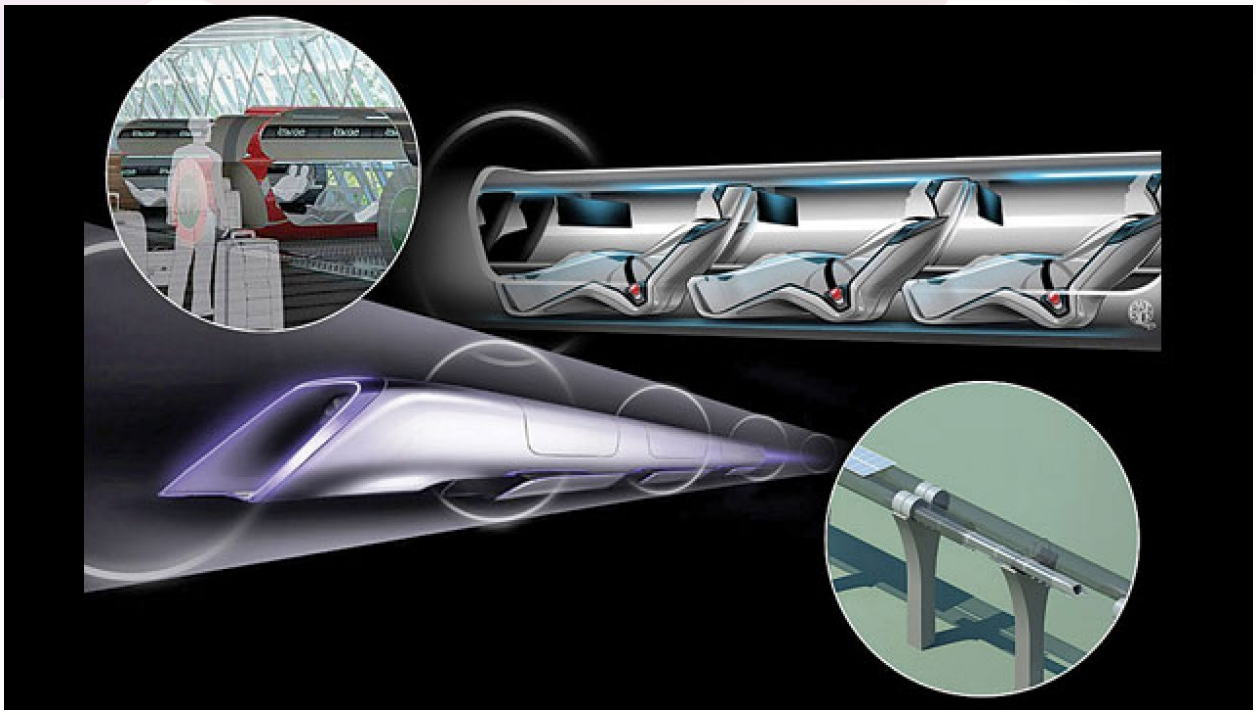
Finally, it's important to consider a geogrid's resistance to installation loads. High dynamic stresses can take their toll on reinforcement while installing and

compacting cover soils and base course materials. To withstand this stress, a geogrid should have thick, monolithic reinforcement bars.

Using geosynthetics provides a more cost-effective and efficient method than many alternatives in a variety of applications.

India on a fast track to make Virgin Hyperloop One a reality

Amrutha Kurup J
B. Tech



From a distance, it looks like a gigantic white caterpillar snaking its way across the desolate desert. We are about 50 km from Las Vegas in an isolated stretch of the Mojave Desert in Nevada.

This is DevLoop, the full-scale test track of the fastest transportation system on land, set up by Richard Branson's Virgin Hyperloop One (VHO). A pod can potentially fly across this vacuum tube at nearly 1000 km/hr. — though the half km test track is too small to test these speeds. While 400 test runs have been successfully done, the pod has not carried a human passenger so far.

Yet, VHO talks confidently of transporting thousands between Mumbai and Pune by the middle of next decade. If all goes to plan, the first VHO commercial project in the world will be in India, and you could travel between the two cities in just 25 minutes.

Why India?

There have been reports about a hyperloop link between Dubai and Abu Dhabi taking off first. But VHO, which together with Roads and Transport Authority and port operator DP World is in discussions with the UAE administration, clarifies the India project is on a faster track. The Maharashtra government has already declared it an official infrastructure project. “It has taken three years to get to the stage we are in India,” says Harj Dhaliwal, Managing Director, India, and the Middle East, Virgin Hyperloop One.

According to VHO, the project is more viable in India. An estimated 80 to 199 million passengers travel between the two Indian cities annually. “VHO can meet this demand by sending pods several times per minute, supporting up to 16,000 passengers per hour per direction at peak capacity,” says Dhaliwal. Incidentally in May 2016, when VHO kicked off a global challenge to find out the most promising hyperloop route, most entries came from India, and the Mumbai-Pune city pair was among the four shortlisted from 2,600 entries. Currently, VHO is exploring a couple of routes in the US in addition to Mumbai-Pune and one in UAE, Dubai-Abu Dhabi.

Rival firm Hyperloop Transportation Technologies (HTT) has proposed two routes in India — one linking new Andhra Pradesh capital Amaravati to Vijayawada and another further afield.

But there is more movement on VHO's Mumbai-Pune corridor with the PMRDA (Pune Metropolitan Regional Development Authority) inviting stakeholder consultation meetings asking for suggestions and objections earlier this year. While VHO has been named the project proponent, others can put in bids too and a Swiss challenge method will be adopted to decide. Apart from VHO and HTT, Canadian company Transpod is also working on ultra-high-speed hyperloop technology.

VHO is confident that Phase One of the Mumbai-Pune project which involves building 11.8 km of a demonstration track with private investment of $500 million by 2023 can move ahead on the timelines promised as there should not be any complications with land acquisition. Phase 2 will see the rest of the stretch built with the track bifurcating into two in Mumbai — one headed to BKC, the other to Navi Mumbai to facilitate cargo movement. The hyperloop corridor will be built either under the Mumbai-Pune Expressway or run parallel.

It's all about air dynamics

She reveals how around 200 engineers, from aerospace, automation, materials, power electronics, civil, software, and systems collaborated on the

project that uses Elon Musk's revolutionary technology with a few adaptations.

To explain it simply, the air inside the tube is eliminated so there is no friction when the pod travels, and an environment that is akin to flying 200,000 ft. above sea level is created. Inside the tube are tracks above which the pod floats through Magnetic Levitation. Thus the energy consumption is low. There are vents in the tunnel from where the atmospheric pressure is vacuumed out to eliminate air dynamic drag. A big tent nearby houses the air pressure management system.

Further away near the security gate is the control room in which around 20 computers and huge display screens monitor the test track.

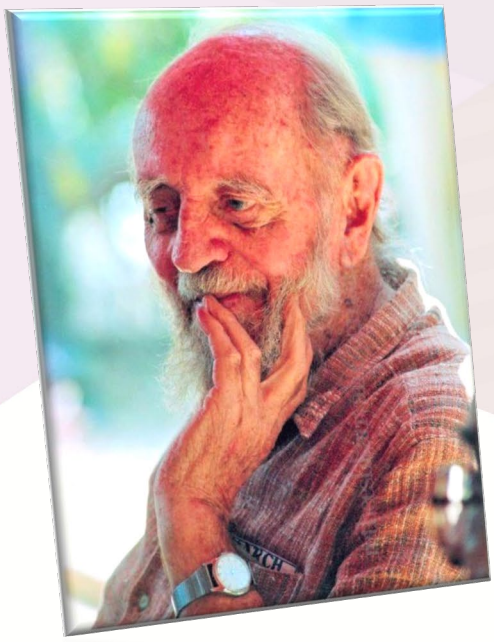
Challenges remain

While the success achieved at DevLoop is impressive, questions on safety remain as humans have not traveled on the pod yet.

VHO also talks of how the project can tap engineering talent from India and create an economic bonanza by boosting local manufacturing.

It's heady talk but until the first humans travel on the pod at speeds promised, we won't know whether the hyperloop is more hype than a realistic vision.

Reference: The Hindu (12/04/2019)



SPIRIT GUIDANCE WITH LAURIE BAKER

AKSHAY RANJITH
B. TECH

'Isn't it a shame that there are so many people who have no access to anything which can be

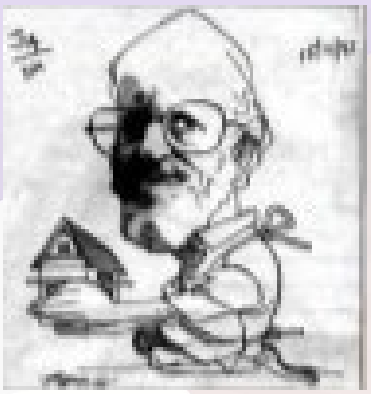
called architecture. We, as architects, highly trained professionals, are doing so little to meet

this very great need. We must never forget that there are 20 million families who are, sadly

deprived, let alone have the benefit of anything called architecture. Not even a hut. It is to our

shame that we allow these figures to increase!'

Lawrence Wilfred Baker, 1986



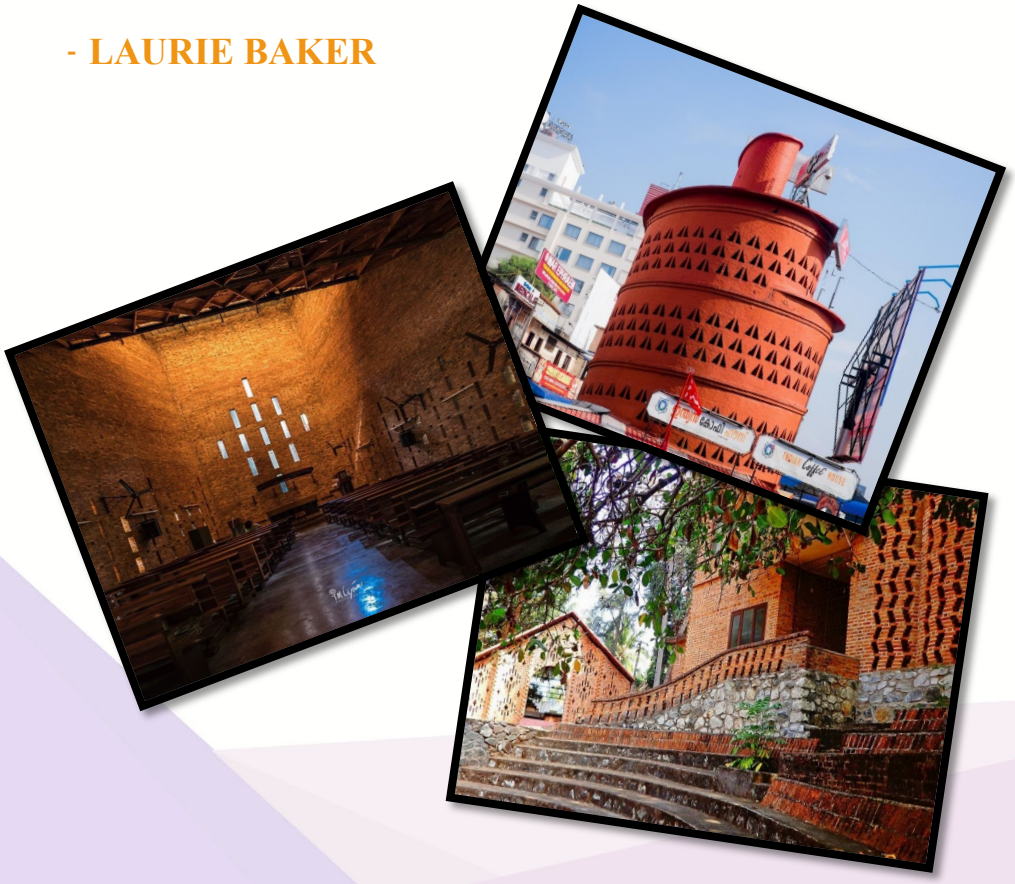
Perspective

Lawrence Wilfred Baker, or Laurie Baker as the Indians called him, gave a new meaning to building design and architecture. What's most amazing is that he did it on a foreign land, where most people didn't even understand the language he spoke. It's said that, he met Mahatma Gandhi, almost by accident, in 1944, and that meeting changed his entire life.

Baker had his critics, especially during the initial phase of his stay in India, several of them terming his work as 'loincloth' architecture, that wouldn't last long as to them. But, as time proceeded Laurie proved them wrong. Interestingly, the concept of sustainable architecture hadn't even arrived, yet many of his principles form a solid foundation for the same.

The first, of course, is that I want to get to know my client and what is in his mind. If he merely wants to show off or flaunt his wealth, I don't take him on. Otherwise, I enjoy getting to know him (or her, a family, an institution or even a government department). "Then I have my own principles, which I am unwillingly to abandon. I dislike falsehood and deceit. A building should be truthful."

- LAURIE BAKER



Legacy

Laurie Baker's writings were published and are available through COSTFORD (Centre of Science and Technology for Rural Development), the voluntary organisation where he was the master architect and had carried out many of his later projects.

Baker's architectural method is one of improvisation, in which initial drawings have only an idealistic link to the final construction, with most of the accommodations and design choices being made on-site by the architect himself. Compartments for milk bottles near the doorstep, windowsills that double as bench surfaces and a heavy emphasis on taking cues from the natural condition of the site are just some examples. His Quaker-instilled respect for nature lead him to let the idiosyncrasies of a site inform his architectural improvisations, rarely is a topography line marred or a tree uprooted. This saves construction cost as well, since working around difficult site conditions is much more cost-effective than clear-cutting. ("I think it's a waste of money to level a well-molded site").

Some important features of the 'Baker Style' are:

Filler Slabs

Rat Trap Bond **Arches**

Resistant to "high-technology" that addresses building environment issues by ignoring natural environment, at the Centre for Development Studies (Trivandrum, 1971) Baker created a cooling system by placing a high, latticed, brick wall near a pond that uses air pressure differences to draw cool air through the building. Various features of his work such as using recycled material, natural environment control and frugality of design may be seen as sustainable architecture or green building with its emphasis on sustainability. His responsiveness to never-identical site conditions quite obviously allowed for the variegation that permeates his work.

Some Notables:

- Centre for Development Studies (Trivandrum)
- Welthy Fisher's Literacy Village (Lucknow)
- Chengalchoola Slum dwelling units (Trivandrum)
- Chitralekha Film Studio (Aakulam)
- The Indian Coffee House (Trivandrum)
- Loyola Chapel & Auditorium (Trivandrum)
- Attapadi Hill Area Development Society
- Pallikoodam School (Kottayam)
- International Leprosy Mission
- Andhra Pradesh Quaker Cyclone Project
- Latur Earthquake Proof Housing Project
- Tsunami-proof Housing Project.

The Hamlet

Gallery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"BIG THINGS ARE BUILT ONE BRICK AT A TIME"

-THE FIRST BRICK