



Department of Civil Engineering

Name of Subject: - EMERGING TRENDS IN CIVIL ENGINEERING (ETC)

Course Code: - 315315

Scheme:- CE-5K

Semester:- Fifth

Unit No. 05 ADVANCE CONSTRUCTION TECHNIQUES

CO5 - Suggest the relevant advance techniques for given construction activity.

Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
I	Advance construction techniques	CO5	6	6	6	2	14

THEORY SYLLABUS CONTENT

UNIT-V ADVANCE CONSTRUCTION TECHNIQUES

- 5.1 Building construction techniques: Pre-engineered building using Mivan technology, Façade Technology, Fire protection buildings, 3D printing.
- 5.2 Road construction techniques: Road Printer, Smart roads, Anti-icing roads, Piezoelectric roads, Hyper loop construction, Precast arch bridge construction.
- 5.3 Ground improvement techniques: Advanced piling techniques : Mono piling, Micro Piles, Soil Nailing, Sand Drains, Pre-Fabricated Vertical Drains, Thermal Methods: Soil heating and Soil freezing.

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(10/1) 20-01/1
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-! Advanced construction techniques :-

Advantages:-

1. sustainability:- Modern construction techniques includes features such as energy efficient, reduction of carbon footprints.
2. Enhanced comfort:- it gives natural benefits instead of artificial comfort.
3. Reduction in energy consumption.

① Building construction techniques

① pre-engineered Building using MIVAN Technology:-

- A faster and monolithic aluminium frame work technology used for multistorey residential and commercial buildings.
- developed by European based company called MIVAN in 1990.
- It enhanced faster construction with uniformity.
- used for township projects.

Advantages:-

- ① time savings.
- ② cost reduction
- ③ Maintain quality
- ④ Maintain uniformity.
- ⑤ panels can be used for 250 times.

Disadvantages:-

- ① Maintenance of MIVAN Frame are difficult.
- ② To be cost effective it needs consistent elevations and planning.
- ③ during the rainy season, seepage and leaks are caused by frame work.

Advantages and Disadvantages: —

Advantages	Disadvantages
- light in weight so easily handle - As it has a fixed set of procedure its installation doesn't required any skilled labour - superior quality is obtained due to casting of whole structural components - more resistant to seismic forces.	- Very less or in fact, no scope for future modification. - the shear walls may cause higher generation of heat of hydration. - contraction cracks are major for mivan frame work. - The finished surfaces might have visible finishing lines as the components used are of small size.

Examples: —

singapore — HDB-type mass housing.

malaysia — High rise condominiums.

dubai — Residential towers.

Facade technology

- Facade technology is the skill of solving design, environmental, and structural challenges to create the external layer of usable spaces interconnected to the main parts or units of building design - architecture, structural engineering and building services into one smooth system.
- Facade → Italian → outer space of building.

Advantages and disadvantages :-

Advantages	Disadvantages.
- quick and simple installation - Lower in cost. - It has higher durability - Versatility.	- low energy efficiency - poor sound insulation. - required more maintenance.

facade.

types of facade system:-

① curtain wall system:- curtain wall is made up by aluminium frames, spandrel panels, and glass panels.

- purpose of this system to protect interior of structure from various weather conditions.

Advantages	Disadvantages.
- Enhancing architectural aesthetic. - optimizing indoor lighting and spatial experience. - Enhancing building energy efficiency and environmental adaptability. - Reducing building loads and adapting to high rise and large span designs.	- high initial construction cost. - Risks of light pollution and heat island effects. - sealing performance failure may lead to leaks. - short comings in winter insulation and summer insulation.

② Ventilated facade system:- it include external cladding that include a facade panel, insulation layer, air cavity.

- Purpose of this system is to maintain air circulation.

Advantages	Disadvantages.
- Thermal comfort - energy efficient. - Enhanced acoustic insulation. - greater building durability	- Higher initial cost. - maintenance is required.

- ③ Kinetic facade! — It include the moving parts of building. such as shutters, panels, and screens that can be adjusted according to the weather conditions, time, day and usage.
- it enhanced the aesthetic of building and provide extra comfort to resident.

Advantages and disadvantages! —

Advantages! — ① solar shading. ② Enhanced thermal comfort
③ Reduced glare ④ dynamic appearance.
⑤ Adaptability ⑥ smart integration.

Disadvantages — ① High initial cost

- ② High maintenance
- ③ mechanical failure
- ④ complex installation
- ⑤ wind and structural consideration.

Fire protection building! —

- it includes the design measures and system that are installed into building against fire.
- it ensures the safety of occupant and minimizing the property damage and casualty.
- it includes fire extinguishers, sprinklers, fire doors, alarms.

Measures! — using fire resistant construction materials.

- provide automatically fire sprinkler system.
- provide fire alarms and notification systems.
- place the fire extinguishers at every corner of building whereas it is quickly accessible
- provide fire exit route while mass crowding.

-! 3D-printing!-

- it is modern manufacturing technology to create buildings, infrastructure and structural components layer by layer using material such as concrete, polymers and geopolymers.

- it reduced construction cost; material waste and labour cost.
- it creates construction elements or entire structures layer by layer using 3D-printer rather than conventional method.

materials used!-

- ① polymers
- ② concrete mixes
- ③ Recyclable materials
- ④ Geopolymers
- ⑤ clay and earth-based materials.

Working!-

to build a digital design by CAD.



3D-printer mixes and prepared specialized material.



deposition of layer.



Arrangement of each grid

Advantage and disadvantages:-

Advantages	Disadvantages
- Improve energy efficiency. - provide thermal comfort. - dynamic aesthetic - user adaptability - environmental responsiveness.	- High initial cost - maintenance requirements - mechanical failure. - complex design and construction - weather vulnerability.

challenges:-

- High initial investment.
- limited resources available.
- skilled workforce required.
- building regulation
- complex to provide structural strength.
- difficult to adaptability against weather conditions.

initial
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! Road construction Techniques! -

- ① Road printer! - it is 3-D based technology
- Road printer is a giant machine designed to make road construction easier.
 - it is 6m in width and laying of whole road in once.
 - it is automatically places bricks or stones into design pattern by given instructions.

Working! -

Material feeding.



Automated laying process



Compaction



Finishing.

Advantages and disadvantages! -

- High productivity
- Reduce labour requirement.
- Reduce material usage.
- Continuous operation
- suitable for complex design.

! Smart Roads! -

- smart roads are those who have adaptive traffic signals, real-time traffic monitoring and vehicle to infrastructure communication
- it improves the transportation efficiency smoothly.
- provide safer to vehicles and vehicles.

features! -

- * Intelligent traffic signals.
- * Road condition monitoring.
- * Real time information
- * Automatic incident detection
- * Electric vehicle charging.
- * smart street lighting.

components! -

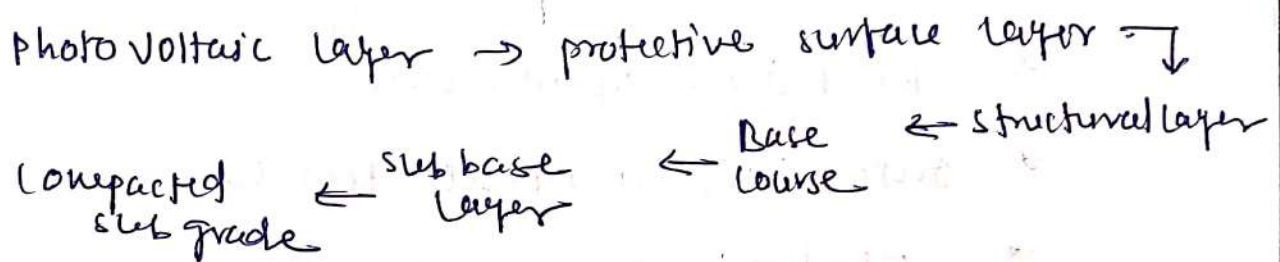
- * sensors
- * CCTV cameras.
- * Variable message sign,
- * Communication system.
- * Traffic management system.

Technologies adopted by smart roads:-

* solar road panels.

solar road panels specially designed that use solar energy to generate electricity when installed on or along side of road. they are smart and sustainable.

② Layers of solar road:-



③ smart intersections:- A road junction that uses sensors, cameras, intelligent traffic signals, communication systems, and data processing to manage traffic safely.

components:-

- 1) smart traffic signal
- 2) Traffic sensors.
- 3) CCTV cameras.
- 4) variable message sign
- 5) traffic management centre.
- 6) smart street light.

* smart street lights:-

- Advanced lighting system that uses sensors, advanced communication tech. and automation in control to manage street light with effectively i.e according to weather, traffic condition
- it saves energy
- to support smart cities system.
- Reduction in resources consumption.

* Wireless vehicle charging:

- it allows an electric vehicles to charge vehicles without plugging in a cable
- Electric energy transferred from a charging pad to a receiver installed underneath the vehicle using EMI (Electromagnetic Induction)
- Electric supply $\rightarrow$ Charging Pad $\rightarrow$ EMF field $\rightarrow$ Receiver

* Road marking:

- it is a lines, symbols, patterns and words displayed onto road surfaces to manage or guide or control traffic and users.
- it is an important component in road construction for safety and smooth transportation

* Frost protection!—

— it is a technique to protect or prevent damage to pavement caused by freezing temp. and frost action.

— Moisture present in soil get expand and can cause surface cracks.

- effects — Frost heaving
 - cracking
 - Pothole
 - uneven pavement.

—! Anti-Icing Road!—

- snow and ice problems often faced by many countries.
- Anti-icing roads are advanced construction technique. It used Advanced material to prevent and reduce ice formation, improving road safety.

Techniques!—

i) Application of snow melt agent!— It includes

- Various types of chlorine salts, non-chlorine salts,
- it reduce the temp below $+4^{\circ}\text{C}$ i.e. ice are melts.
 - Common salts are are used (NaCl).

* Chlorine salts.

- i) sodium chloride
- ii) calcium chloride
- iii) potassium chloride

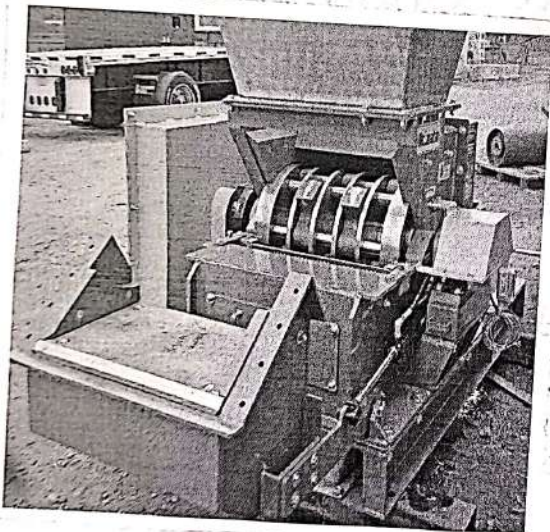
* non-chlorine salts.

- i) calcium magnesium acetate
- ii) carbamide (urea).

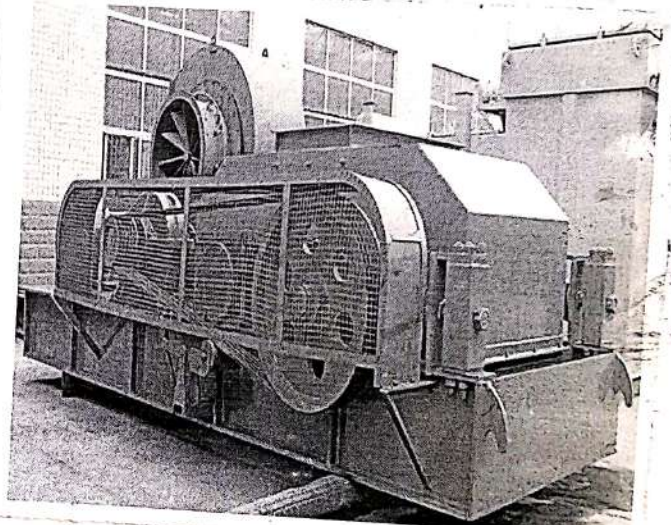
② mechanical method:- it is traditional techniques used to removal of ice.

- This machines are categorized according to their capacity, how they travel, how they operate.
- According to their modes of operation:-

- i) Helical rotor
- ii) Rolling type
- iii) Shovel type
- iv) Hammer crusher type



Helical rotor



Rolling type

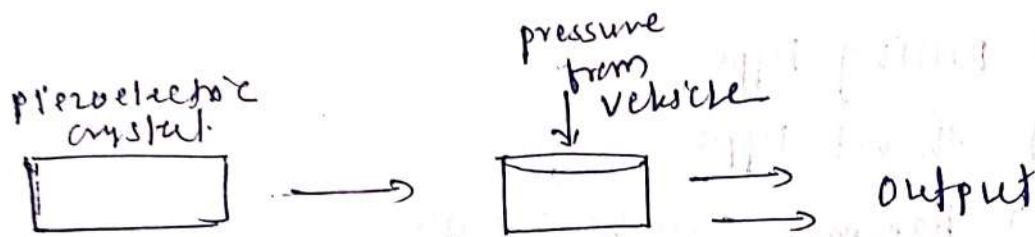


Shovel type.

—: piezoelectric Road:—

- Energy is generated by vibrations of moving objects such as vehicles, humans.
- These special materials can absorb mechanical energy and convert it into electric energy.

Working principle:—



- When crystalline materials are exposed to external pressure, electrical voltage is induced
- crystals — quartz and amaranite.

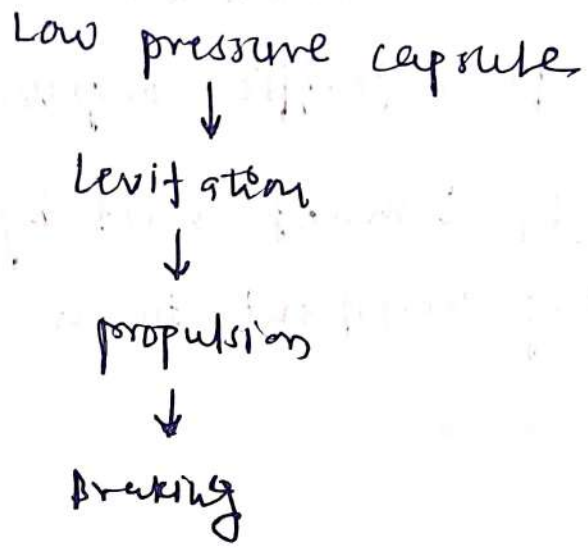
construction of piezoelectric roads:—

- They are constructed in layers with one piezoelectric generators embedded in layer of quick drying concrete
- they covered with bituminous felt to ensure better adhesion of the concrete to the asphalt, which is poured onto the prepared road.

Hyperloop Technology:—

- It is proposed high speed transportation system in which passenger or cargo pods travel through a capsule with low pressure at high speed.
- It reduces the air resistance and friction.

Working:—



Travelling in a Tube

THE TECHNOLOGY

A capsule, with passengers, travels at speeds of more than **1200 KM/H** inside a vacuum tube

Vacuum tube has an area of **LOW PRESSURE** INSIDE IT

INDIA PLANS

Hyperloop can be built in India in **38 MONTHS**

Globally, **800 ENGINEERS** working on the Hyperloop, of which **25 ARE FROM INDIA**

It uses power from **RENEWABLE ENERGY** sources like solar energy, regenerative braking & wind power

These tubes stand on pylons that can **WITHSTAND** quakes & crashes

Advantages:-

- travel with very high speed.
- energy consumption is less than other transportation.
- less carbon emissions.
- free from traffic congestion.
- energy demand met by solar energy.
- Highly resistant to weather.

Challenges:-

- construction cost is very high.
- difficult to maintain lower pressure over a long distance.
- Thermal expansion of long tubes.
- difficult to public acceptance.

examples:-

mumbai - pune — proposed
(speed - 600 - 1000 km/hr)

Advanced piling Techniques:—

Mono piling:—

Advanced piling technique in which single, large diameter, high capacity concrete pile is constructed at a location to transfer heavy loads to deep and hard strata of soil or rock.

Method:—

site investigation



drilling/excavation



cleaning of bore



RIF placement



concrete pouring.



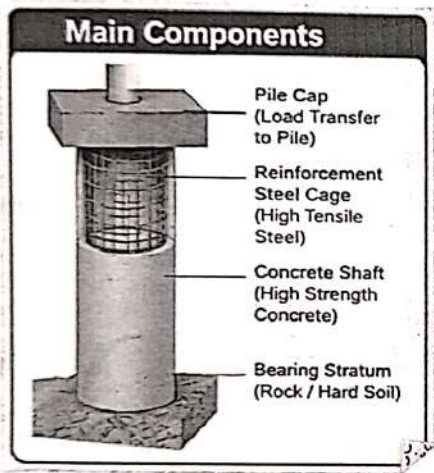
curing.



Pile cap construction

Applications:—

- high rise buildings
- Bridges / Flyover
- Marine construction
- Wind turbine foundation
- offshore structure



Advantages:—

- High load carrying capacity
- Suitable for high rise structure
- Requires less number of pile than other system.
- minimize differential settlement.
- long service life with low maintenance.

micro piling!— it has small diameter, high strength piles used to transfer loads from a structure to deep and competent soil or rock, suitable for restricted access and low headroom conditions.

Method!—

site investigation



drilling



Rib installation



Grouting



pile head finishing.

Features!—

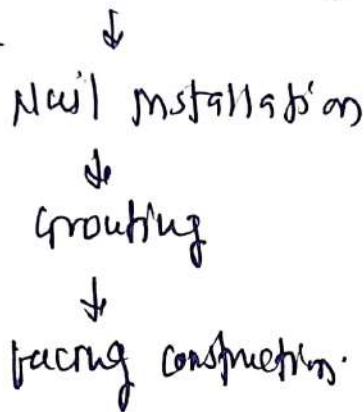
- small dia. (100-300mm)
- High load carrying capacity
- minimal vibration and noise
- used in urban areas and sensitive structures

Applications!—

- for retrofitting
- load transfer in weak or compressive soil.
- temporary work and marine construction.

Soil nailing: — It is ground improvement technique ⁽¹⁰⁾ used to stabilize and retain soil or rock slopes by intersecting steel bars (nails) into the ground and connecting them with facing to create a tensioned reinforced soil mass.

Method: — site investigation



Advantages: —

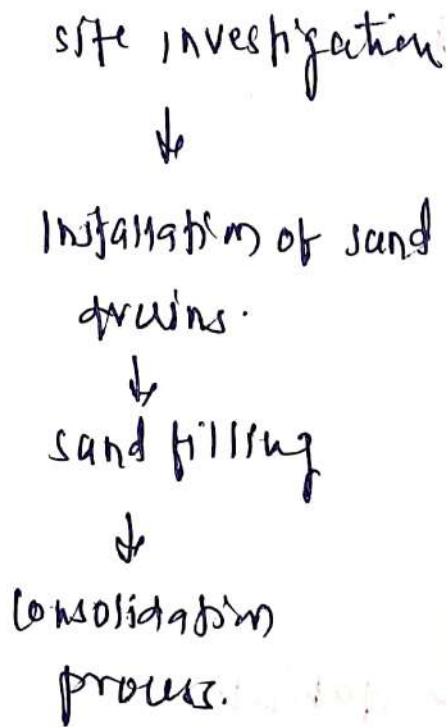
- provide immediate slope stability.
- Economical and fast construction
- suitable for both soil and rock
- flexible and allows small deformation.
- required minimum excavation

Applications: — used in construction of retaining wall.

- Stabilization of road and railway cutting
- To support basement walls.
- slope stabilization in hilly areas.

Sand drains: — It is also ground improvement technique used to accelerate the consolidation of soft, water-logged clay by providing vertical drainage path for expelled pore water.

Method :-



Advantages —

- Accelerates consolidation of soft clay.
- To reduce time for primary consolidation
- minimize post construction settlement.
- cost effective

Applications! — foundation for embankments on soft clay.

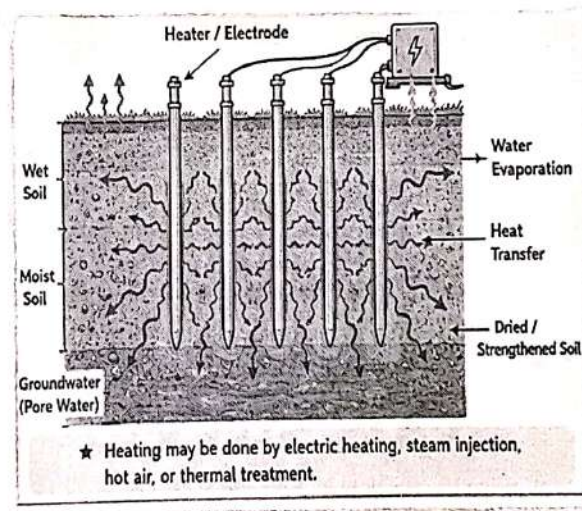
- road and railway
- Industrial Infrastructure.
- coastal and reclamation works.

Thermal methods of ground improvement. (11)

④ Soil Heating:— used in advanced construction and environmental remediation to alter the temp. profile of the ground.

— it means warming up the ground by applying heat in a controlled way.

— The engineering properties of clay soil undergo significant changes when heated to approximately 400°C .



Applications:— strengthening wet or soft soil.

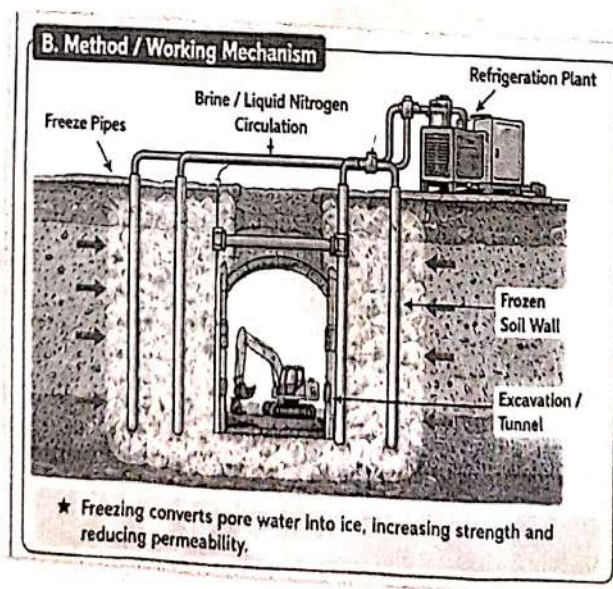
- expelling pore water and reducing moisture content.
- Improving bearing capacity for foundations.
- stabilization of contaminated soil in special project.

Soil Freezing! - to decrease the temp. of ground until the water betw the soil particles turns into ice. this frozen water acts like glue i.e holding the soil particles together.

- it can be applied to any type of rock or soil regardless of its permeability, structure or particle size,

Applications! -

- Temporary support for deep excavation and shafts.
- groundwater control in tunneling
- stabilization of loose or water bearing soils.
- Forming an impermeable frozen wall around excavation.





Unit-05 Advance Construction Technique



1. **Mivan technology is mainly used for:**
 - A. Road construction
 - B. Fast and repetitive building construction
 - C. Soil testing
 - D. Bridge inspection
2. **3D printing in construction is mainly used to:**
 - A. Print construction materials and building components
 - B. Measure traffic speed
 - C. Improve soil drainage
 - D. Remove ice from roads
3. **Which technique is used to improve weak soil by installing vertical drainage paths?**
 - A. Soil nailing
 - B. Sand drains
 - C. Piezoelectric roads
 - D. Façade technology
4. **Micro piles are generally used when:**
 - A. Deep or restricted-access foundations are required
 - B. Roads need anti-icing
 - C. Buildings need painting
 - D. Traffic signals need repair
5. **Soil freezing is a ground improvement method that:**
 - A. Temporarily increases soil strength by freezing pore water
 - B. Removes all groundwater permanently
 - C. Increases soil temperature
 - D. Produces electricity
6. **The primary purpose of façade technology in modern buildings is to:**
 - A. Improve only the foundation
 - B. Provide an efficient external building envelope
 - C. Replace all structural columns
 - D. Increase soil permeability
7. **Piezoelectric roads can generate electrical energy by:**
 - A. Using solar panels below the road

- B. Converting mechanical stress from traffic into electrical energy
 - C. Freezing the pavement
 - D. Using underground turbines
8. **Pre-fabricated vertical drains (PVDs) are mainly used to:**
 - A. Construct building façades
 - B. Increase pavement temperature
 - C. Accelerate consolidation of soft saturated soils
 - D. Prevent structural fires
9. **Soil nailing improves the stability of soil slopes by:**
 - A. Adding water to the soil
 - B. Removing all soil from the slope
 - C. Heating the soil
 - D. Installing reinforcing elements into the soil mass
10. **Anti-icing roads are designed primarily to:**
 - A. Increase vehicle speed
 - B. Generate electricity from traffic
 - C. Improve soil bearing capacity
 - D. Prevent or reduce ice formation on the pavement
11. **Which combination correctly matches the technique with its main function?**
 - A. Piezoelectric road — Prevents all traffic accidents
 - B. Soil freezing — Permanently removes groundwater
 - C. PVD — Accelerates consolidation of soft clay
 - D. Mivan — Used primarily for soil stabilization
12. **In thermal soil improvement, soil heating is particularly useful because it can:**
 - A. Modify soil properties and accelerate certain physical processes
 - B. Permanently eliminate all settlement
 - C. Replace foundation piles in every situation
 - D. Convert soil directly into concrete
13. **What is a major advantage of precast arch bridge construction?**
 - A. It eliminates the need for structural design
 - B. Structural components can be manufactured in controlled conditions and

rapidly assembled on site

C. It requires unlimited on-site casting time

D. It can only be used for temporary roads

14. Hyperloop construction requires special attention to alignment because:

A. The system operates with vehicles moving at very high speeds in a controlled guideway

B. It is designed for slow-moving agricultural vehicles

C. It depends entirely on soil freezing

D. It does not require a guideway

15. A project is being constructed on soft, highly compressible soil where rapid construction is required. Which combination is most appropriate for improving ground performance?

A. PVDs with preloading to accelerate consolidation

B. Piezoelectric pavement with façade technology

C. Soil nailing with fire protection systems

D. 3D printing with anti-icing chemicals

Answers:-

1-B	2-A	3-B	4-A	5-A
6-B	7-B	8-C	9-D	10-D
11-B	12-A	13-B	14-A	15-A