

# SUBSTRUCTURE CONSTRUCTION TECHNIQUES: BOX JACKING & PIPE JACKING



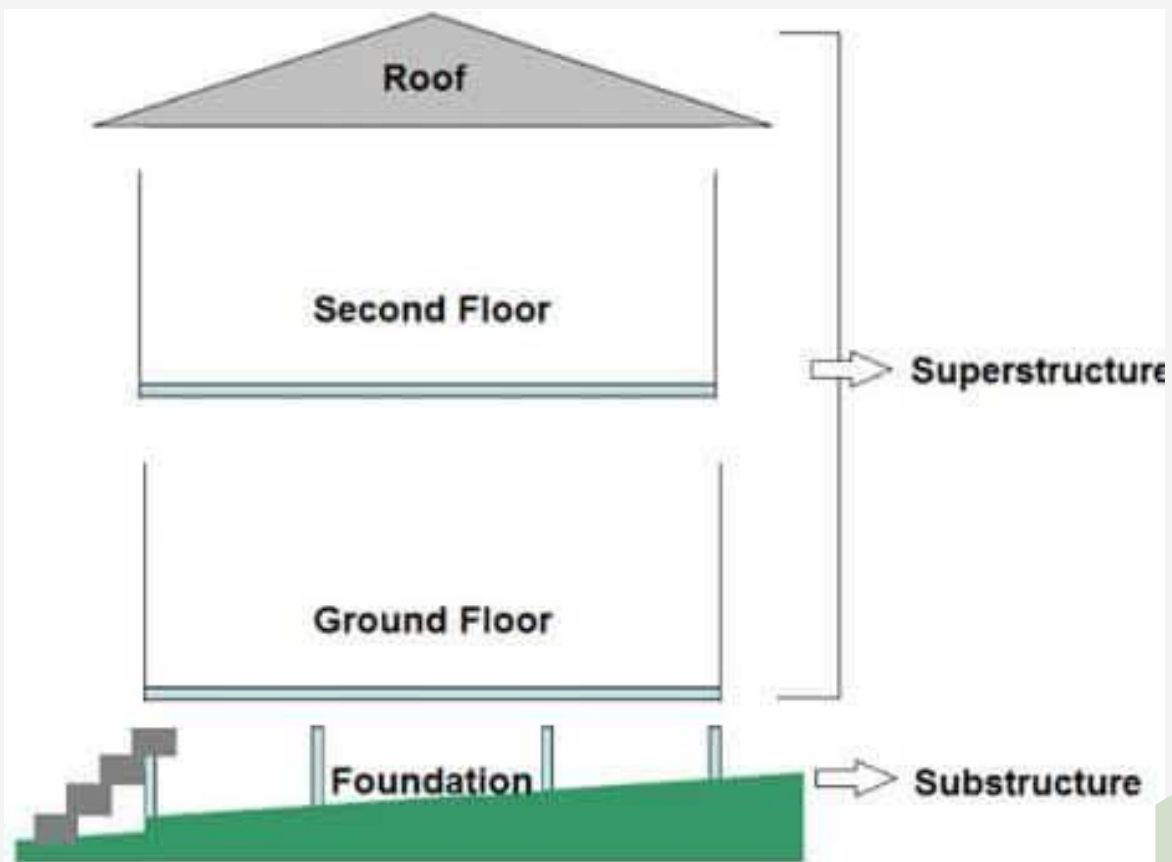
# SUBSTRUCTURE



# WHAT IS SUBSTRUCTURE ?

The substructure is the lower part of a building which is constructed below the ground level. The function of substructure is the transfer of loads from the superstructure to the underlying soil. So, the substructure is in direct contact with supporting soil. Substructure involves footing and plinth of a building.


The substructure base is constructed using either reinforced cement concrete or plain cement concrete . The cement concrete is covered with bricks or stone and additional concrete to the desired plinth level. A damp-proof course is then laid on top to prevent moisture from penetrate the substructure.





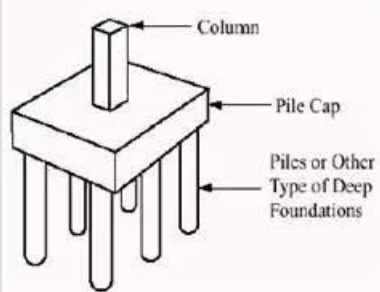
# COMPONENTS

The basic components of a building substructure are the foundation (**Strip foundation, Raft foundation, Pile foundation**) and plinth beam. These components safely transfer the load from the supersructure to the ground.



# TYPES OF FOUNDATION

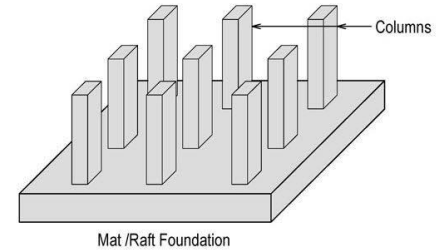
Pile foundation



Strip foundation



Raft foundation



SUPERSTRUCTURE	SUBSTRUCTURE
<ul style="list-style-type: none"><li>•This portion of a building is built above ground level.</li></ul>	<ul style="list-style-type: none"><li>•This portion of a building is built below ground level.</li></ul>
<ul style="list-style-type: none"><li>•May include walls, floors, beams, windows, doors, and columns.</li></ul>	<ul style="list-style-type: none"><li>•It consists of the foundation, plinth.</li></ul>
<ul style="list-style-type: none"><li>•Transfers load from the upper part of the building to the substructure.</li></ul>	<ul style="list-style-type: none"><li>•Transfers loads from the superstructure to the soil underneath the building.</li></ul>
<ul style="list-style-type: none"><li>•Provides living space and protects the building from the elements.</li></ul>	<ul style="list-style-type: none"><li>•It supports the structure and prevents it from collapsing.</li></ul>

# PRESENTED BY

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# BOX JACKING

- Aalam Singh Grewal

# What is box jacking?

Box jacking is a tunnelling method that involves the jacking of rectangular reinforced cement concrete (RCC) sections into the ground. The practice is used in highway construction as well as in trenchless operations such as constructing culverts under road and rail embankments.

Precast reinforced concrete box sections are jacked horizontally through the ground using high-capacity hydraulic jacks. Only that portion of the earth that the jacked box will occupy is excavated. The box jacking method was adopted in the 1960s based on the success achieved with pipe jacking techniques. As a trenchless construction method, box jacking offers the advantage of minimal disruption while the tunneling is underway. It has been used for railway or subway tunnels, as well as the installation of culverts and other smaller projects.

Box jacking is also called tunnel jacking or jack box tunnelling.



# Benefits of Box Jacking

The box jacking method can adapt to shallow overburden and higher structural section utilization compared to circular pipe jacking. Since the method is trenchless, it has a minimum impact on surface traffic and on surrounding structures and does not require intermediate ground supports. The process is simple, safe, economical, and well-established. The method can be used in many applications, including:

- To install storm drains.
- Pedestrian trails.
- Under crossings for livestock and wildlife, in many industrial settings.
- For roadways.





Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat / Copernicus  
Image IBCAO

Google Earth

[https://youtu.be/UwvL8\\_yNEg](https://youtu.be/UwvL8_yNEg)

# STEPS IN BOX JACKING

First, a shaft is sunk up to the level of jacking, and supports are provided to facilitate the jacking process.

The precast concrete boxes are either constructed at the site or transported to the site before the operation can begin. The box is lined up and placed exactly in line with its final position

The soil at the face is excavated using an excavator. As excavation proceeds, the hydraulic rams push the concrete box into the ground. During jacking, a lubricant is pumped around the box to facilitate easy passage.

The process is continued till all the concrete box sections are inserted into the ground safely. Once the installation is completed, grout is injected to displace the lubricant.

01



02



03



04





# SUB STRUCTURE CONSTRUCTION TECHNIQUE: PIPE JACKING

- AMITOJ SINGH

# CONTENT:

## WHAT DOES PIPE JACKING MEAN?

Introduction about pipe jacking

01

## HISTORY

Brief history of pipe jacking

02

## METHODOLOGY

Planning, procedure, process  
based upon soil, pipe jacking  
force, Failure

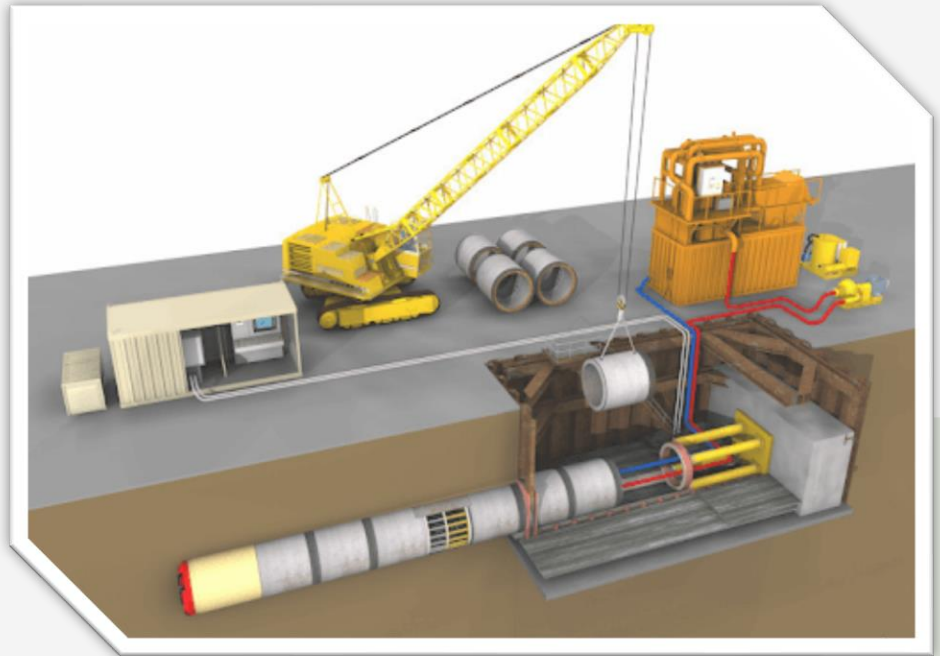
03

## APPLICATIONS, ADVANTAGES & DISADVANTAGES

04

## WHAT DOES PIPE JACKING MEAN?

Pipe jacking is a trenchless method of installing pipes, conduits, and utility corridors by applying a force which pushes the pipe through the ground while controlled excavation takes place at the face.





## KEY POINTS:

01

### PROCESS

Pipe jacking process begins with excavating relatively entry and exit pits at the beginning and end of the pipe installation.

02

### PITS FOR PIPE JACKING

These pits are just large enough to accommodate the tunneling equipment and construction personnel. Once the pits are excavated, the hydraulic jacking rig and microtunneling machine are put into position.

03

### FORCE APPLIED

The hydraulic jacking rig then applies a force that "pushes" the tunneling machine through the wall of the entrance pit and into the ground. Once the machine reaches a predetermined position in the soil, a segment of pipe is lowered into the entrance pit behind the jacking rig and the micro tunneling machine.

04

### PIPE RAMMING

The jacking rig, once again, applies a force that forces both the pipe and machine forward on their way to the exit pit. This process continues, with several pipe segments being jacked in sequence until the cutter head reaches the exit pit.

Pipe jacking can also be referred to as pipe ramming.

# HISTORY

01

WORLD

First mentioned in 1910, USA by Richardson & Mayo, in 60's used in UK and American pipe jacking association was formed.

02

WORLD

In 70's process is industrialized in Japan, in 80's developed in Europe.

1800mm diameter trenches pipe is laid for 460m in London  
560m water bearing sand and gravel.

03

INDIAN

First project is of 3.5km in 1988, Mumbai.

In Cuttack 10km is constructed for sewer using trenchless method.

04

INDIAN

Other projects of less than 8km is completed in Goa, Hyderabad, Kolkata, Delhi, Assam. A total of around 100km is build so far using trenchless method.

# METHODOLOGY

## PROCEDURE

- The thrust pit and the reception pit are excavated at the required places.
- In case of mechanized excavations, a very large pit is required.
- But in case of manual excavation, a small pit is enough.
- Thrust ring is provided to ensure the even distribution of stress along the circumference of the pipe. The number of jacks vary upon the frictional resistance of the soil, strength of pipes etc.,
- The size of the reception pit is to be big enough to receive the jacking shield.
- To maintain the accuracy of alignment a steerable shield is used during the pipe jacking.

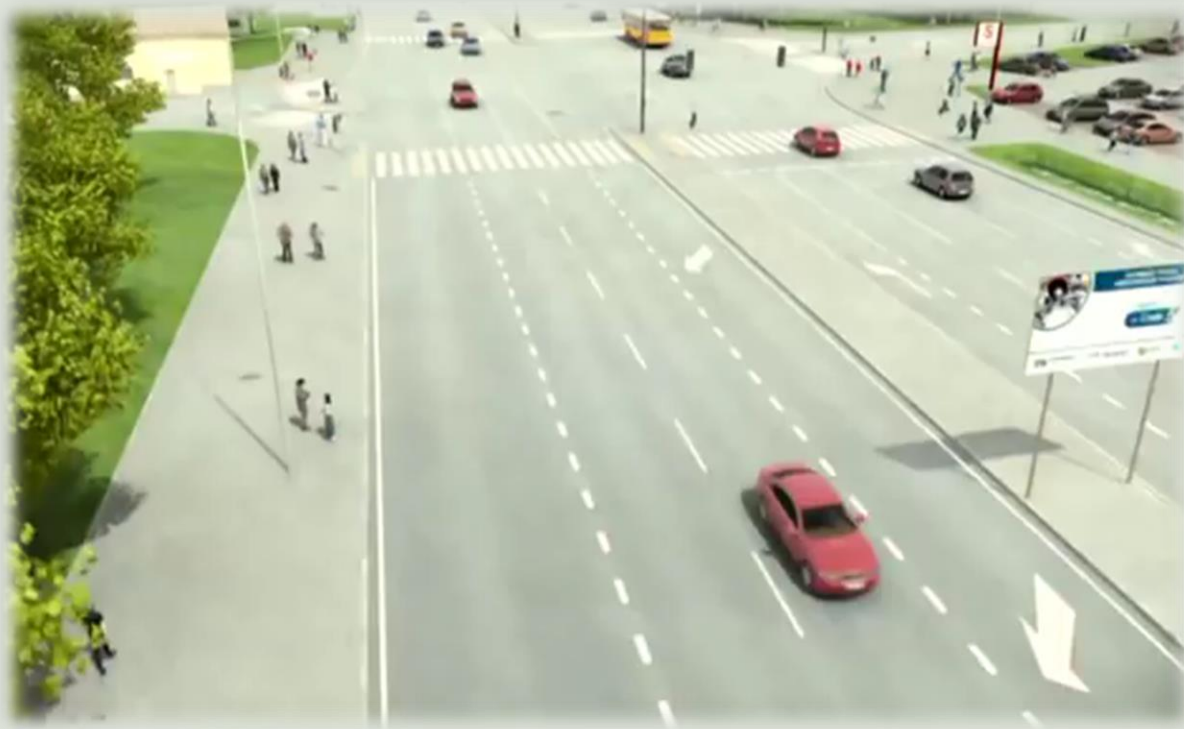
## PLANING

- Understand the site history and potential obstructions.
- Look at old aerial photos.
- Conduct a geotechnical program.
- Locate all existing utilities.
- Minimize costs.
- Develop the best cross section.
- Use the right materials.

## FAILURE

- Pipe generally fail from the corner first.
- Maximum force is acting at the edges due to: Uneven distribution of jacking force from one pipe to another. Unavoidable curvature.

# METHODOLOGY



<https://www.youtube.com/watch?v=WyimKWVoRME>

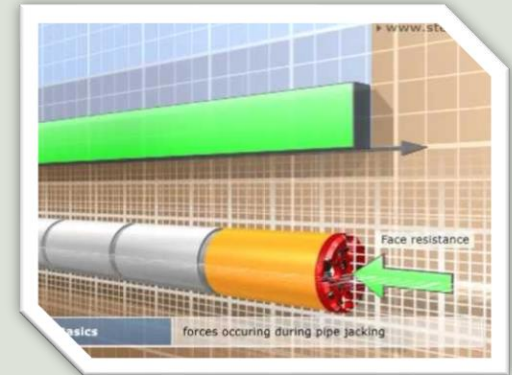
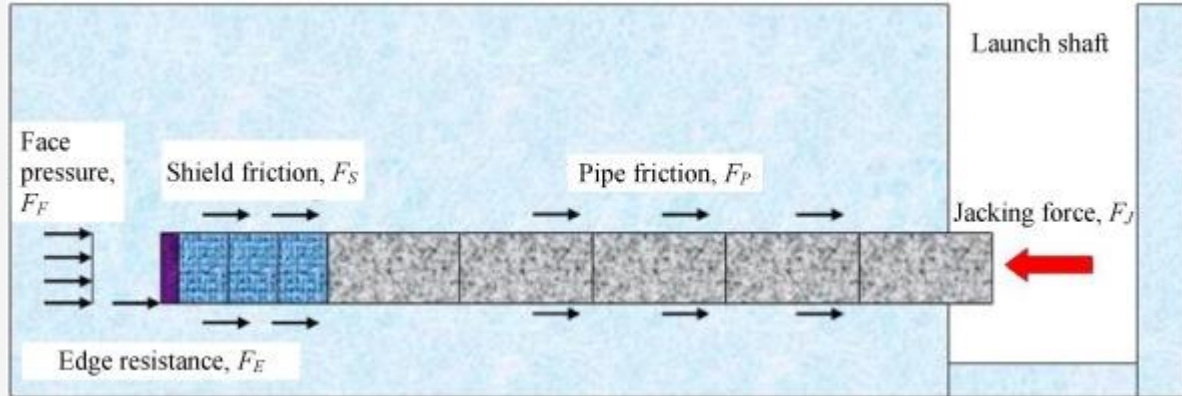
# Resistance to Pipe jacking force

## FORCE ON JACKED PIPE

- PIPE DEAD WEIGHT
- PENETRATION RESISTANCE
- SOIL PIPE FRICTION

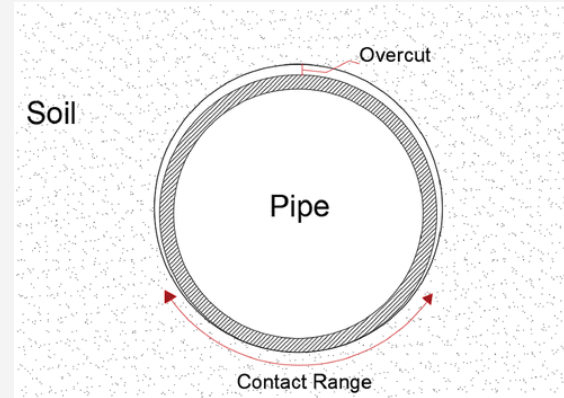
## OTHER FORCES:

- CURVATURE FORCE
- SOIL DEAD LOAD
- LIVE LOAD



# Soil Conditions Suitable for Pipe Jacking

**Stable soil:** Face excavation may precede the jacking operation. All spoils removed through the inside of the pipe to the jacking pit.



**Weak soil:** When jacking in extremely weak soils, since there may not be enough soil strength to support the intended alignment. In such cases, strengthening or stabilization methods, such as ground freezing or grouting may be required.

Poor ground conditions may also possess inadequate strength to provide the necessary reaction against which to jack. In this case, piles or other strengthening arrangements may be needed to increase the reaction capability of the thrust wall.

These additional measures, do, however, increase the overall cost of the drive.

# APPLICATIONS

- Larger Diameter Pipe
- Oil pipelines Industrial pipelines
- Telecommunication
- Pedestrian subways
- Sewers, and drainage construction
- Gas and water mains.



## ADVANTAGES

- It avoids the excavation of trenches.
- Quick set-up, timely finish of projects.
- Good quality control and good grade of pipe used.
- Can be remotely operated.
- Versatile in various ground conditions.
- Cost efficient for large length pipe.
- Reduces disruption to existing services.
- Environment friendly.



## DISADVANTAGES

- Costly for small lengths.
- Skilled personal is required.
- Dewatering of tunnel path is usually required.
- Not feasible for nature of soil changes drastically.
- Hard rock/Bed rock or very big boulders should not be present in the path line.




## Questions:

Ques 1: Name trenchless method of installation of pipes?

Ques 2: What is Box jacking?

Ques 3: What is Pipe ramming?

Ques 4: Any two benefits of box jacking?



A photograph of a modern building's facade. The building is constructed from light-colored, textured concrete panels. A large, dark brown, sans-serif word "THANKS" is mounted on a wide horizontal concrete slab. Below this slab, there are three dark, rectangular window openings, each framed by a thin concrete border. The building is set against a light blue sky. A large, solid light green shape, resembling a stylized mountain or a large letter 'A', is positioned to the right of the building. A thin green vertical line is visible on the far left edge of the image.

**THANKS**