# DI04006071: Railway, Harbour & Tunnel Engineering

## Lecture 5.40: Classification, Location, size, Shape, and construction of Shaft

GTU Course Instructor

Civil Engineering

July 23, 2026

# Introduction to Shafts I

Shafts are vertical or inclined passageways excavated from the surface downwards to provide access to underground tunnels or workings. They serve as critical infrastructure during both the construction phase and the operational phase of a tunnel system.

## Key Points

- Provide access for personnel and equipment
- Facilitate removal of excavated muck
- Act as ventilation ducts
- Serve as drop shafts for materials

# Classification of Shafts I

Shafts are primarily classified based on their longevity and structural permanence. Temporary shafts are utilized only during the construction phase and are subsequently backfilled, while permanent shafts remain functional throughout the tunnel's lifespan for maintenance and ventilation.

## Key Points

- Temporary Shafts: Backfilled after tunnel completion
- Permanent Shafts: Lined heavily for long-term use
- Inclined Shafts: Easier for conveying materials
- Vertical Shafts: Most common, direct vertical access

# Functional Classification of Shafts I

| Shaft Type | Primary Function | Typical Lifespan | Lining Requirement |
|---|---|---|---|
| Working Shaft | Muck and material transport | Temporary | Light to moderate |
| Ventilation | Air circulation and exhaust | Permanent | Heavy and durable |
| Drop Shaft | Gravity feeding of concrete/materials | Temporary/Permanent | Moderate |
| Access Shaft | Personnel entry and emergency exit | Permanent | Heavy with stairs/elevators |

## Key Points

- Working Shaft: Muck removal, equipment lowering
- Ventilation Shaft: Fresh air supply, exhaust
- Drop Shaft: Material transfer via gravity

# Location Criteria for Shafts I

The positioning of a shaft is determined by geological, topographical, and logistical factors. Ideally, a shaft should be located where the overburden is minimal and ground conditions are stable, ensuring safety and reducing excavation costs.

## Key Points

- Proximity to the tunnel alignment
- Favorable geological and hydrological conditions
- Accessibility for construction equipment and transport
- Avoidance of built-up areas and existing utilities

# Determining the Size of a Shaft I

Shaft dimensions are dictated by the required hoisting capacity, the size of equipment to be lowered, and the ventilation needs. Working shafts must accommodate muck buckets, material cages, and service pipes simultaneously.

## Key Points

- Diameter usually ranges from 3m to 10m based on purpose
- Clearance required for hoisting skips and cages
- Space allocation for dewatering pipes and power cables
- Future capacity requirements for permanent shafts

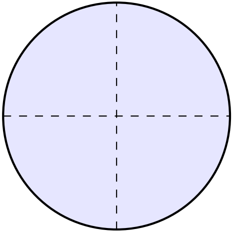
# Geometrical Shapes of Shafts I

The structural integrity and excavation efficiency of a shaft depend heavily on its cross-sectional shape. Circular shafts are most popular due to their ability to withstand high lateral earth and water pressures efficiently.

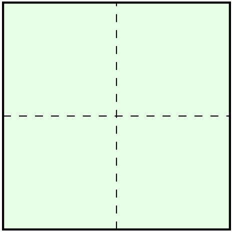
## Key Points

- Circular: Optimal stress distribution, ideal for weak soils
- Rectangular: Easier to divide into compartments, suitable for rock
- Elliptical: Used for accommodating dual large cages
- Polygonal: Rarely used, mainly for specialized architectural shafts

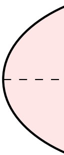
# Typical Cross-sectional Shapes of Shafts I



Circular Shaft



Rectangular Shaft



## Key Points

- Circular shapes resist compressive forces radially
- Rectangular shapes are easier for timbering in hard rock
- Elliptical shapes balance pressure resistance and spatial needs

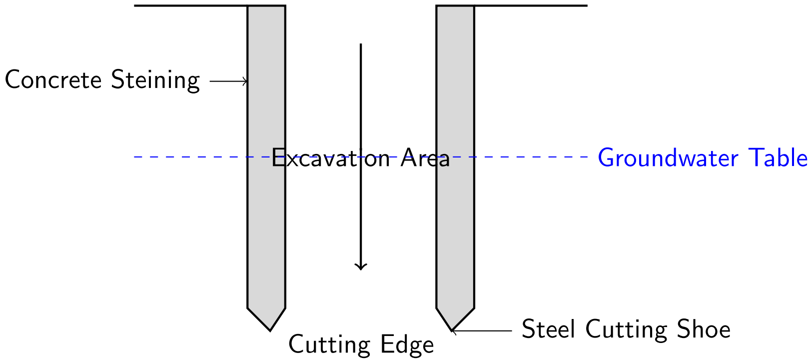
# Shaft Sinking and Construction Methods I

The method chosen for sinking a shaft depends on the depth, ground conditions, and water table level. Traditional drill and blast is used for hard rock, while mechanized methods are deployed in softer, water-bearing soils.

## Key Points

- Drill and Blast: Standard for competent rock strata
- Caisson Sinking: Used in soft, water-logged soils
- Ground Freezing: Stabilizes flowing soils and groundwater
- Raise Boring: Excavating upwards from an existing pilot tunnel

# Drop Shaft (Caisson) Construction Method I



# Drop Shaft (Caisson) Construction Method II

## Key Points

- Shaft lining is built above ground and sinks by its own weight
- Cutting edge cuts into soil as interior is excavated
- Ideal for penetrating loose, water-bearing strata
- Skin friction must be overcome using bentonite slurry

# Safety and Temporary Support during Sinking I

Shaft sinking is a hazardous operation requiring rigorous safety protocols. Temporary supports, also known as shaft timbering or primary lining, are essential to prevent side collapse before the permanent lining is cast.

## Key Points

- Shotcrete and rock bolts for initial stabilization in rock
- Steel ring beams and lagging in weaker soils
- Continuous dewatering and ventilation are mandatory
- Protection against falling objects using headgear and penthouses

# Summary I

Shafts are indispensable components of tunnel engineering, classified by their lifespan and functionality. Their design—encompassing location, size, and shape—requires careful geological consideration. Sinking methods vary from traditional blasting to advanced caisson techniques, all demanding strict adherence to safety standards.

## Key Points

- Classification depends on operational longevity and specific use
- Location and size dictate logistical efficiency
- Circular cross-sections offer the best structural stability
- Construction method is dictated by geotechnical conditions