

STAGES IN TUNNEL CONSTRUCTION

- **Investigations:** Investigations are made to find necessary information for proposed tunnel site. Informations to be collected are:
 - (i) Origin of soil mass.
 - (ii) Hydrology in surrounding proposed tunnel site.
 - (iii) Presence of foul gases.
 - (iv) Temperature of soil nearby.
 - (v) Physical and mechanical strength of soil mass existing at proposed site.
 - (vi) Location of weak geological features like faults, folds, etc.
- Investigations to collect information are made in the following stages:
 1. Investigations made prior to planning the project.
 2. Investigations made at the time of planning the project.
 3. Investigations made at the time of construction.
- 1. **Investigations before planning:** Geological investigations are made to determine relation between bed rock and top soil when exploration at the surface in form of knowing morphology, petrology, stratigraphy, etc. Geophysical methods like electrical resistivity methods are used to locate positions of weak zones like faults, folds and shear zones.
- 2. **Investigations at the time of planning:** Investigations at the time of planning are made through drilling holes either by:
 - (i) Percussion
 - (ii) Rotary percussion
 - (iii) Rotary
 Rotary or Rotary percussion methods are used for investigating loose soils while rotary drilling method is used for rocky soils.
- 3. **Investigations at the time of construction:** Information at the time of construction is achieved by driving either of the following:
 - (i) **Heading:** Heading is part of tunnel cross-section excavated for small lengths.
 - (ii) **Driving drift:** Heading and drift give information regarding stratification, fault, fold, presence of foul gases, etc. exactly in tunnel alignment. Heading gives information at the time of

construction, while drift gives complete information prior to construction of tunnel.

- When such holes are drilled as the work proceeds, they are known as headings.
- Drift or heading provide space for setting service lines.
- When these holes are drilled for the entire length of tunnel in the beginning, the holes are known as drifts.

BLASTING

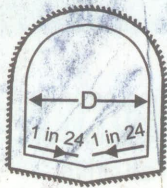
- Nowadays non-explosive techniques of fragmentation like laser and electron beams are available, the primary methods of drilling and blasting are yet used for rock release.
1. **Types of explosives**

(i) Straight dynamites	(ii) Ammonia dynamites
(iii) Ammonia gelatine	(iv) Semi-gelatine
(v) Blasting agents	(vi) Slurries or water gels
 2. **Cuts:** The blast is made to get initial cut or void of rock release with creation of fresh free face so that other following cut or cuts shall release more and more rock i.e. to say initial blast must release satisfactory amount of rock and free face for blast to follow.
 - (i) Angle cut
 - (ii) Burn cut
 3. **Theory of blasting:** Process by which rock can be blasted is divided into following groups:
 - (i) Impact
 - (ii) Abrasion
 - (iii) Thermally induced spalling
 - (iv) Fusion and vaporization
 - (v) Chemical reaction
 When excavation is to be done in rock usually blasting is resorted.

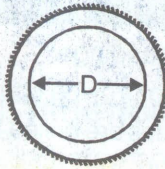
SHAPE AND SIZE

Following are the usual cross-sections adopted for tunnels.

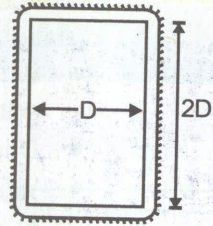
1. **'D' section :** In rock tunnels, the risk of failure or collapse caused by external pressure from water or loose or unstable soil conditions on tunnel lining is practically non-existent and it is then convenient to have a section with an arched roof and straight sides, which is called the 'D' section or segmental-roof section.



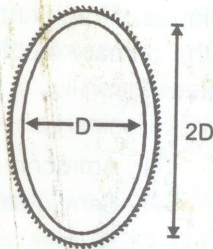
(a) 'D' Section



(b) Circular Section



(c) Rectangular Section



(d) Egg-shaped section



(e) Horse-shoe section

Shapes for tunnel cross-sections

This section is suitable for sub-ways or navigation tunnels.

2. **Circular section:** For tunnels which may have to withstand heavy internal or external radial pressures, this form is the most desirable.
3. **Rectangular section:** This section is suitable only in case of hard rocks.
4. **Egg-shaped section:** This section is commonly used for carrying sewage because it gives self-cleansing velocity even in dry weather flow.
5. **Horse-shoe form:** It is the best shape suited for traffic purposes and as the floor of the tunnel is nearly flat, it gives working space to the contractor to store materials during construction.

PORTALS

- The actual doorways or main entrances of the tunnels are known as portals and thus, a portal indicates the intersection point between the underground opening and the ground surface.