UNIT III PLANNING AND GEOMETRIC DESIGN OF TUNNELS

3.1 Topographical Surveys

Detailed topographic maps, plans and profiles should be developed to establish primary control for final design and construction based on a high order horizontal and vertical control field survey. Accurate topographic mapping is also required to support surface geology mapping and the layout of exploratory borings. The principal survey techniques include:

- Conventional Survey
- Global Positioning System (GPS)
- Electronic Distance Measuring (EDM) with Total Station
- Remote Sensing
- Laser Scanning,

Global Positioning System (GPS)

Utilizes the signal transit time from **ground station to satellites** to determine the **relative position** of monuments in a control network.

GPS surveying is able to coordinate widely spaced control monuments for **long range surveys**, as well as **shorter range surveys**.

The **accuracy** of GPS measurement is **dependent** upon the **number** of satellites observed, **configuration** of the satellite group observed, **elapsed time** of observation, **quality** of transmission, **type** of GPS receiver, and other factors including network design and techniques used to process data.

The **drawback** for GPS survey is its **limitation in areas** where the **GPS** antenna **cannot establish** contact with the satellites via direct line of sight, such as within tunnels, downtown locations, forested areas, etc.

Electronic Distance Measuring (EDM)

Utilizes a **digital theodolite with electronic microprocessors**, called a "total station" instrument, which determines the distance to a remote prism target by measuring the time required for a laser or infrared light to be reflected back from the target.

EDM can be used for **accurate surveys** of distant surfaces that would be difficult or impractical to monitor by conventional survey techniques.

EDM can be used for **common surveying applications**, but is particularly useful for economically monitoring displacement and settlement with time, such as monitoring the displacement and settlement of an **existing structure during tunneling operations**.

Remote Sensing

It can **effectively identify** terrain conditions, **geologic** formations, **escarpments** and surface reflection of **faults**, buried stream beds, site access conditions and general soil and rock formations.

Remote sensing data can be **easily** obtained **from satellites** (i.e. LANDSAT images from NASA), and aerial photographs, including infrared and radar imagery, from the USGS or state geologists, U.S. Corps of Engineers, and commercial aerial mapping service organizations.

State **DOT aerial** photographs, used for right-of-way surveys and **road** and **bridge** alignments, may also be available.

Laser Scanning

Utilizes laser technology to **create 3D digital images** of surfaces.

Laser scanning equipment can establish **x, y and z coordinates** of more than **one thousand** points per second, at a resolution of about 0.25 inch over a distance of more than 150 feet.

Laser scanning can be used to **quickly scan** and **digitally record** existing slopes to determine the geometry of visible features, and any changes with time.

In tunnels, laser scanning can efficiently **create cross sections** at very close spacing to document conditions within **existing tunnels** (Figure 3-3), verify geometry and provide as-built sections for newly constructed tunnels, and to monitor tunnel deformations with time.