- Earthwork Operations & Equipments
Earthwork Operations

Those construction processes that involve the soil or earth in its natural form and that precede the building of the pavement structure itself

- Basic earthwork operations:
  1. Clearing & Grubbing
  2. Excavation: Roadway & drainage excavations; and borrow excavation.
  3. Embankments
  4. Finishing Operations
## Equipments Used in Earthwork Operations

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<th>Equipment Type</th>
<th>Typical Uses</th>
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<td>Bulldozers</td>
<td>Loosening rocky earth, short distance earthmovings</td>
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<td>Motor grader</td>
<td>Shaping pavement layers &amp; slopes</td>
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<td>Crane</td>
<td>Excavation, placing &amp; handling, lifting</td>
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<td>Trucks &amp; Wagons</td>
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<td>Rollers</td>
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<td>Loaders</td>
<td>Excavation, filling, cleaning</td>
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<td>Scrapers</td>
<td>Digging, loading, transporting, dumping, &amp; spreading</td>
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Clearing & Grubbing

- First operation in earthwork prior to excavation.
- Removal of trees, roots, rubbish, and other objectionable material from the planned or designated area of proposed excavation and embankment or any area where obstructions must be removed.
- Clearing: Removal of material above ground.
- Grubbing: Removal of roots and similar objects to a nominal depth below the surface.
- Constitute a single contract item (removal of topsoil to a shallow depth) measured in Acres.
Excavation

● AASHTO
  ● Rock excavation: Cannot be excavated without blasting, or boulders > 2 m³
  ● Common excavation: All materials of whatever character, not classified.
  ● Unsuitable excavation: Deposits of saturated or unsaturated of soil & organic matter unacceptable for embankment material.
  ● Borrow excavation: Approved material required for construction of embankment.

● More preferred to use Unclassified excavation instead to describe excavation of all materials, regardless of their nature.
Roadway & Drainage Excavation

- Excavation & grading of the roadway & ditches, including the removal of all excavated material for the construction of cuts, embankments, slopes, ditches, intersections,…etc.
- Measurement of excavated materials is based on the volume (cubic meters).
- Most of the equipments listed can be used in this operation.
Excavations of material in order to permit the construction of pipe culverts, concrete box culverts, foundation of bridges, retaining walls, and all other structures that may be required in a particular job.

Payments are made separately for this item based on actual volume excavated.

Both machines & hand methods are used.
Borrow Excavations

- When materials for formation of embankment from excavations within the limits of right of way are insufficient, additional suitable material is generally taken from borrow pits.
- When work finished borrow pits should not be left in condition where water can ponds.
- Payment are based on volume (cubic meters) measure by original volume.
Embankments

- Used in highways when it is required that the grade line of the roadway be raised some distance above the level of the existing ground surface in order to maintain design standards or prevent damage of the highway through the action of surface or ground water.

- Basic factors:
  - Height: Maintain grade near bridges, culverts, or mountainous regions, raise from groundwater.
  - Slope: flat slopes are preferred, right of way constraints, good material allow using steeper slopes after checking on safety.
  - Foundation: Stability of side slope along with its foundation (underlying soil) should be checked for design.
  - Material: A-1 to A-3 are more desirable
Construction of Rolled-Earth Embankments

- Thin layers of loose soil (15 to 30 cm).....Rolled to satisfactory degree of density....before next layer is placed.....till desired height obtained.
- Layer thickness can be higher when large rocks are used in the lower portion of the fill.
- Construction:
  - Direct dump & spreading by scraper.
  - Dumping from trucks and spread by graders or Dozers
- Compaction: % of max density (dry bases)...
  - field density test (Sand cone test).
  - Nuclear guages
Special Treatment of Embankment Foundation

The foundation of embankments that are constructed in swampy areas require special treatment if failure is to be avoided:

- Gravity Subsidence
- Partial or total excavation
- Blasting
- Jetting
- Vertical Sand drains
- Reinforcement with Engineering fabrics
Finishing Operations

Final series of operations that are required to complete the earthwork operations involved in a typical highway project.

Operations:
- Shoulders trimming.
- Side & ditch slopes.
- Cut sections (scarifying, shaping, compacting)
- Final grade cross-section.

Operations are generally carried along & performed as the job approached completion.

Motor grader is the most widely used tool.
Job scheduling (construction schedule)

- Tabulate general operations (bar charts).
- Assign time required for completion of each operation. (certain operations overlap)
- Show sequence of operations.
- Draw hatched bars to show progress been made. (helps contractor to determine the status of the work).

- Applied for every phase of the complete project
- Some contractors prepare a detailed sheet that show equipments, labor and material requirements for every day of the project.
Critical Path Method (CPM)

- An analysis & management tool that is useful in planning & scheduling any project made up of various subunits.
- CPM basic concept: Among the many operations that from a project, there must be one series of sequential operations that can be longer than any other possible series. The shortest possible time in which the project can be completed is the time needed for the longest series. The critical series is the critical path.
- Determination of the critical path is in itself an exercise in logic that promotes good management of the project.