Distance Measurement

Introduction

- Distance is one of the most basic engineering measurements.
- Early measurements were made in terms of the dimensions of the body.

- **Cubits** - the distance between the tip of your middle finger to the elbow.
- Typically to measure cords and textiles.
  (another measure was 24 digits or 6 palms)

- **Fathom** - distance between the tips of your middle finger when your arms are outstretched (~6 feet).
- The name comes from the Danish faedn, "outstretched arms."

- **Foot** - distance from the tip of a man’s big toe to the heel.
- **Rod** - the sum of the lengths of the left feet of 16 randomly chosen people coming from church service.

Pacing

- The ability to pace distance is very useful.
- A person can determine their pace by counting the number of paces necessary to walk a distance that has been previously measured.

- A pace is defined as one step.
- A stride is considered two steps.
For centuries engineers have measured distances with ropes, lines, or cords.

The term chaining is a carry–over from the time when the Gunter chain was used (1600’s).

Gunter’s chain was designed and introduced in 1620 by English clergyman and mathematician Edmund Gunter (1581–1626).

In 1785 U.S. a federal law stated that all government surveys must be done with a Gunter’s chain.
Distance Measurement

Taping or Chaining

- Gunter’s Chain lies at the origin of the definition of an acre.
- The original acre was an area of land suitable for ploughing with a defined amount of work (e.g., ten furrows long, each furrow being ten chains, permitting rests of an oxen team).
- It measured one chain by one furlong (totaling 10 square chains).
- Early two-lane roads were laid out with a chain, resulting in a 66-ft. right-of-way.

Distance Measurement

Taping or Chaining

The word acre is derived from Old English æcer originally meaning "open field".

Distance Measurement

Taping or Chaining

Tapes are available in lengths up to 1,000 feet; precision of 1/1,000 to 1/5,000 are commonly obtained.

Distance Measurement

Electronic Distance Measurement (EDM)

EDMs measure the time required for a light wave to sent to a target and reflected back.

Electronic Distance Measurement (EDM)

EDMs are very useful in measuring distances that are difficult to access or long distances.

Distance Measurement

Electronic Distance Measurement (EDM)

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**Taping over Level Ground**
- If the taping is done over level ground where there is no underbrush, the tape can rest on the ground.
- A taping crew consists of two people: the head tapeperson and the rear tapeperson.
- The head tapeperson takes one end of the tape and walks down the line towards the point.
- If the distance is more than 100-ft., then the head tapeperson places a taping pin at the 100-ft. interval and the process is repeated.

**Taping over Sloping Ground**
- If the taping is done over sloping ground where there is no underbrush, the taping must be done in sections, referred to as breaking the tape.
- Holding the tape more than five feet above the ground is difficult, therefore slopes greater than 5 ft. per 100 ft. will require runs of less than 100 ft.

**Review of Basic Trigonometry**
For a right triangle, let's consider the basic trigonometric functions.

\[ A^2 + B^2 = C^2 \quad a + b + c = 180^\circ \]
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**Review of Basic Trigonometry**

\[ \sin(b) = \frac{B}{C} \quad \cos(b) = \frac{A}{C} \quad \tan(b) = \frac{B}{A} \]

Determine the height of a flag pole. Assuming that the ground is level, a 250.0 ft. length is measured out from the base of the steeple and a 20°15’ vertical angle is determined from that point on the ground to the top of the steeple.

\[ \tan(20.25°) = \frac{h}{250.0 \text{ ft.}} \quad \Rightarrow \quad h = 250.0 \times \tan(20.25°) \]

\[ h = 92.2298... \text{ ft.} \]

\[ h = 92.23 \text{ ft.} \]

End of Distance Measurements