

# Simple Machines

## Mechanical Advantage (MA)

$$IMA = \frac{D_E}{D_R} \qquad AMA = \frac{F_R}{F_E}$$

$$\% \text{ Efficiency} = \left( \frac{AMA}{IMA} \right) 100$$

IMA = Ideal Mechanical Advantage

AMA = Actual Mechanical Advantage

$D_E$  = Effort Distance       $D_R$  = Resistance Distance

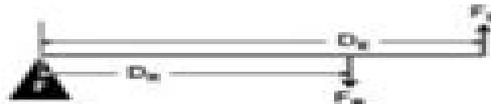
$F_E$  = Effort Force       $F_R$  = Resistance Force

## Lever

1st Class



2nd Class



3rd Class

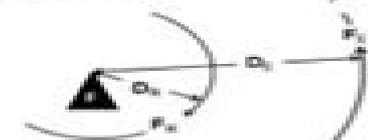


## Wheel and Axle

Effort at Axle



Effort at Wheel



## Pulley Systems

IMA = Total number of strands of a single string supporting the resistance

$$IMA = \frac{D_E \text{ (string pulled)}}{D_R \text{ (resistance lifted)}}$$

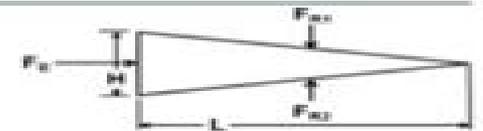
## Inclined Plane

$$IMA = \frac{L \text{ (slope)}}{H}$$



## Wedge

$$IMA = \frac{L \text{ (L to height)}}{H}$$



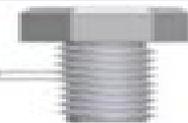
## Screw

$$IMA = \frac{C}{\pi r H}$$

$$\text{Pitch} = \frac{1}{\text{TPI}}$$



Pitch



C = Circumference

r = radius

Pitch = distance between threads

TPI = Threads Per Inch

## Compound Machines

$$MA_{\text{TOTAL}} = (MA_1) (MA_2) (MA_3) \dots$$

## Gears; Sprockets with Chains; and Pulleys with Belts Ratios

$$GR = \frac{N_{\text{out}}}{N_{\text{in}}} = \frac{d_{\text{out}}}{d_{\text{in}}} = \frac{\omega_{\text{in}}}{\omega_{\text{out}}} = \frac{T_{\text{out}}}{T_{\text{in}}}$$

$$\frac{d_{\text{out}}}{d_{\text{in}}} = \frac{\omega_{\text{in}}}{\omega_{\text{out}}} = \frac{T_{\text{out}}}{T_{\text{in}}} \text{ (pulleys)}$$

## Compound Gears

$$GR_{\text{TOTAL}} = \left( \frac{B}{A} \right) \left( \frac{D}{C} \right)$$



GR = Gear Ratio

$\omega_{\text{in}}$  = Angular Velocity - driver

$\omega_{\text{out}}$  = Angular Velocity - driven

$N_{\text{in}}$  = Number of Teeth - driver

$N_{\text{out}}$  = Number of Teeth - driven

$d_{\text{in}}$  = Diameter - driver

$d_{\text{out}}$  = Diameter - driven

$T_{\text{in}}$  = Torque - driver

$T_{\text{out}}$  = Torque - driven

# Civil Engineering Material Quantity Formulas

**Ivan S. Macdonald, Robert Craik  
McLean, Frederick Reed, M. B. Toutloff**

## **Civil Engineering Material Quantity Formulas:**

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Home Study ,1897    **The American Engineer** ,1882    **Indian Engineering** ,1923    Materials of Engineering: Iron and steel ... 2d. ed Robert Henry Thurston,1885    **Annual Catalogue of the Agricultural and Mechanical College of Texas. Session ...** Agricultural and Mechanical College of Texas,1929    **Engineering-contracting** ,1907

*Construction* Ivan S. Macdonald,Robert Craik McLean,Frederick Reed,M. B. Toutloff,1922    *Engineering News-record* ,1881

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## **Table of Contents Civil Engineering Material Quantity Formulas**

1. Understanding the eBook Civil Engineering Material Quantity Formulas
  - The Rise of Digital Reading Civil Engineering Material Quantity Formulas
  - Advantages of eBooks Over Traditional Books
2. Identifying Civil Engineering Material Quantity Formulas
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Civil Engineering Material Quantity Formulas
  - User-Friendly Interface
4. Exploring eBook Recommendations from Civil Engineering Material Quantity Formulas
  - Personalized Recommendations
  - Civil Engineering Material Quantity Formulas User Reviews and Ratings
  - Civil Engineering Material Quantity Formulas and Bestseller Lists
5. Accessing Civil Engineering Material Quantity Formulas Free and Paid eBooks
  - Civil Engineering Material Quantity Formulas Public Domain eBooks
  - Civil Engineering Material Quantity Formulas eBook Subscription Services
  - Civil Engineering Material Quantity Formulas Budget-Friendly Options

6. Navigating Civil Engineering Material Quantity Formulas eBook Formats
  - ePub, PDF, MOBI, and More
  - Civil Engineering Material Quantity Formulas Compatibility with Devices
  - Civil Engineering Material Quantity Formulas Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Civil Engineering Material Quantity Formulas
  - Highlighting and Note-Taking Civil Engineering Material Quantity Formulas
  - Interactive Elements Civil Engineering Material Quantity Formulas
8. Staying Engaged with Civil Engineering Material Quantity Formulas
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Civil Engineering Material Quantity Formulas
9. Balancing eBooks and Physical Books Civil Engineering Material Quantity Formulas
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Civil Engineering Material Quantity Formulas
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Civil Engineering Material Quantity Formulas
  - Setting Reading Goals Civil Engineering Material Quantity Formulas
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Civil Engineering Material Quantity Formulas
  - Fact-Checking eBook Content of Civil Engineering Material Quantity Formulas
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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