TABLE XVIII
LINEAR FEET COVERED BY TANK OF ANY CAPACITY FOR VARIOUS WIDTHS AND RATES OF APPLICATION

<table>
<thead>
<tr>
<th>Width (in feet)</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate (in gal/yd²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>0.1</td>
<td>300</td>
<td>200</td>
<td>150</td>
<td>120</td>
<td>100</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>0.2</td>
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<td>100</td>
<td>75</td>
<td>60</td>
<td>50</td>
<td>37</td>
<td>30</td>
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<tr>
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<td>40</td>
<td>30</td>
<td>24</td>
<td>20</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

Note:
In many instances it will be easier to make such computations from data contained in Table XVIII-IV using appropriate multiplying factors. For example, it is apparent that the number of linear feet covered by a 1000-gallon tank, for a given width, would be twice that covered by a 2000-gallon tank of the same width. If the tank capacity is not in some convenient multiple, such as a 3000-gallon tank, the data contained in Table XVIII-IV for the 3000-gallon tank may be multiplied by an appropriate factor. For the 3000-gallon tank, the multiplying factor would be 3000 / 2000 = 1.5. An example of such a computation for the 3500-gallon tank is as follows:

1. Table XVIII-IV indicates that a 3000-gallon tank will cover 375 linear feet when applied to a strip 12 feet wide and at a rate of 0.25 gallon per yd².
2. A 3500-gallon tank would cover 1.3 times this distance, or 3.3 × 3750 = 12,375 linear feet.

To compute the number of linear feet which will be covered by a tank of any capacity, for various widths and rates of application, use the following formula:

\[
L = \frac{C}{W} \times R
\]

Where:
- \( L \) = No. of linear feet which will be covered
- \( C \) = Capacity of tank in gallons (or quantity of asphalt in tank)
- \( R \) = Rate of application in gallon per sq yd
- \( W \) = Width of application in feet

Example:
If a 5000-gallon tank is applied to a strip 18 feet wide at a rate of 0.30 gallon per yd², the number of linear feet covered is:

\[
L = \frac{5000 \text{ gal}}{18 \text{ ft}} \times 0.30 \text{ gal/ft²} = 1250 \text{ linear ft}
\]
### TABLE XV-16
**QUANTITIES FOR VARIOUS DEPTHS OF CYLINDRICAL TANKS IN HORIZONTAL POSITION**

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<th>% of Capacity</th>
<th>Depth Filled</th>
<th>% of Capacity</th>
<th>Depth Filled</th>
<th>% of Capacity</th>
<th>Depth Filled</th>
<th>% of Capacity</th>
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<td>80.39</td>
<td>99</td>
<td>99.80</td>
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</table>

Full capacity of tank in U.S. gallons = 0.7854 x D^2 x L

Note: The formula for direct computation of quantity when tank is less than half full is shown below. When more than half full, compute the full capacity of the tank as noted above; consider the shaded portion to represent the unfilled portion at the top of the tank and compute this volume as indicated below; then, deduct the volume determined for the unfilled portion from the total volume of the tank to arrive at the volume of the filled portion.

First, compute where \(\theta = \frac{d}{R-L}\)

Then \(A = \pi R^2 \theta \div 180 - \pi \sin \theta (R - h)\)

And \(V = L \pi R^2 \theta \div 180 - \pi \sin \theta (R - h)\)

Where \(A\) = Cross sectional area of filled portion of tank in sq in
\(V\) = Volume of filled portion of tank in U.S. gallons
\(L\) = Length of interior in tank in inches
\(D\) = Diameter of interior in tank in inches
\(R\) = Radius of interior in tank in inches
\(h\) = Depth of liquid in inches
\(d\) = \(R - h\), inches

Note: The volume occupied by any piping, fittings or other material inside the tank must be deducted from the volume computed by use of the table or formula.

---

### TABLE XV-17
**TEMPERATURE CONVERSIONS °F to °C and °C to °F**

The formula for converting °F to °C is: °C = \(\frac{5}{9} (°F - 32)\)

The formula for converting °C to °F is: °F = \(\frac{9}{5} °C + 32\)

To use the following table, locate the temperature to be converted in the center column which is in boldface type. If the temperature to be converted is in °C, the temperature in °F will be found in the column to the right. If the temperature to be converted is in °F, the temperature in °C will be found in the column to the left. For example, to convert 25°C to °F, locate 25 in the center (boldface) column. In the column to the right, under °F, it is found that 25°C = 77°F.
<table>
<thead>
<tr>
<th>°C</th>
<th>Temp. to Convert °C</th>
<th>°F</th>
<th>Temp. to Convert °C</th>
<th>°F</th>
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<td>+120</td>
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<td>49.4</td>
<td>121</td>
</tr>
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<td>50.0</td>
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<td>125</td>
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<td>76</td>
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<td>126</td>
</tr>
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<td>+25.0</td>
<td>77</td>
<td>170.6</td>
<td>52.8</td>
<td>127</td>
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<td>53.3</td>
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<tr>
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<td>79</td>
<td>174.2</td>
<td>53.9</td>
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</table>

--- 356 ---

--- 357 ---
### TABLE XV-17 (Continued)

<table>
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<th>Temp. to Convert</th>
<th>°C to °F</th>
<th>Temp. to Convert</th>
<th>°C to °F</th>
<th>Temp. to Convert</th>
<th>°C to °F</th>
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358

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359
### TABLE XV-18
TEMPERATURE OF LIQUIDS HEATED BY STEAM AT VARIOUS GAUGE PRESSURES

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<th>Gauge Pressure in Lbs Per Square Inch</th>
<th>Temperature of Saturated Steam Degrees Fahrenheit</th>
<th>Highest Temp. a Liquid Can be Heated in a Vessel With Heating Equipment 85% Efficient</th>
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### TABLE XV-19
WEIGHT PER CUBIC FOOT AND PER CUBIC YARD OF DRY MINERAL AGGREGATES FOR AGGREGATES OF DIFFERENT SPECIFIC GRAVITY AND VARIOUS VOID CONTENTS

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</table>

#### Notes:
1. The Specific Gravity of commonly used road construction aggregates normally is within the following range:
   - Granite 2.6-2.9
   - Sand (Quarztzite) 2.5-2.7
   - Blast Furnace Slag 2.0-2.7
   - Limestone 2.2-2.4
   - Tramprock 2.5-2.7

2. Data contained in this table are applicable to dry mineral aggregates in either the loose or compacted state, and the void content should be selected accordingly. Preferably, both the void content and specific gravity should be determined in the laboratory.

3. The formulas for computation of data in table above are as follows:
   - Per Cu Ft
     \[ W = \frac{62.4 	imes (100 - V)}{100} = 0.624 (100 - V) \]
   - Per Cu Yd
     \[ W = \frac{27 	imes 62.4 	imes (100 - V)}{100} = 16.85 (100 - V) \]

Where:
- \( W \) = Wt. per cu ft
- \( W \) = Wt. per cu yd
- \( G \) = Specific gravity
- \( V \) = Air void content, percent
### TABLE XV-20
WEIGHT AND VOLUME RELATIONS FOR VARIOUS TYPES OF COMPACTIONed ASPHALT PAVEMENTS

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<th>lbs Per Cubic Ft</th>
<th>lbs Per Cubic Yard</th>
<th>lbs Per Square Yard</th>
<th>lbs Per 1 Inch Depth</th>
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### TABLE XV-21
POUNDS PER SQUARE YARD OF MATERIAL REQUIRED FOR VARIOUS DEPTHS AND WEIGHTS OF MATERIALS IN POUNDS PER CUBIC YARD

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Note: Formula used for calculations: \( a = \frac{(D)}{(36)} \) Weight = \( \frac{q}{W} \) Where: 
- \( q \) = Quantity of material in lbs per sq yd
- \( D \) = Depth in inches
- \( W \) = Weight of material in lbs per cu yd
### TABLE XV-22

**TONS OF MATERIAL REQUIRED PER 100 LINEAR FEET FOR VARIOUS WIDTHS AND POUNDS PER SQUARE YARD**

<table>
<thead>
<tr>
<th>Lbs Per Sq Yd</th>
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<th>4</th>
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<th>10</th>
<th>20</th>
<th>40</th>
<th>60</th>
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<tbody>
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<td>0.01</td>
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<td>0.17</td>
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<td>0.03</td>
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<td>0.17</td>
<td>0.20</td>
<td>0.23</td>
<td>0.26</td>
<td>0.29</td>
<td>0.43</td>
<td>0.56</td>
<td>0.70</td>
</tr>
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<td>0.05</td>
<td>0.07</td>
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<td>0.25</td>
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<td>0.45</td>
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<tr>
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<td>0.07</td>
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<td>0.11</td>
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<td>0.13</td>
<td>0.15</td>
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<td>0.53</td>
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<td>0.38</td>
<td>0.40</td>
<td>0.46</td>
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<td>0.53</td>
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<td>0.78</td>
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<td>0.92</td>
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<td>1.31</td>
<td>1.45</td>
<td>1.59</td>
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</table>

**Note:** Formulas used for calculations:

\[ w = \left( \frac{W}{100} \right) \left( \frac{R}{2000} \right) - 0.005556 RW \]

Where:
- \( W \) = Weight of material in tons per 100 feet
- \( R \) = Rate of application in lbs per sq yd
- \( W \) = Width of application in feet

---

### TABLE XV-23

**TONS OF MATERIAL REQUIRED PER MILE FOR VARIOUS WIDTHS AND POUNDS PER SQUARE YARD**

<table>
<thead>
<tr>
<th>Lbs Per Sq Yd</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
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<th>9</th>
<th>10</th>
<th>20</th>
<th>40</th>
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<td>0.01</td>
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<td>0.13</td>
<td>0.17</td>
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<td>0.23</td>
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<td>0.23</td>
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<td>0.43</td>
<td>0.56</td>
<td>0.70</td>
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<td>0.05</td>
<td>0.07</td>
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<td>0.21</td>
<td>0.24</td>
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<td>0.39</td>
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</table>

**Note:** Formulas used for calculations is as follows:

\[ w = \left( \frac{W}{3} \right) \left( \frac{5280}{2000} \right) R = 0.2933 RW \]

Where:
- \( R \) = Rate of application in lbs per sq yd
- \( W \) = Width of application in feet

---

*364*
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<tr>
<th>Lbs Per Sq Yd</th>
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### Note: Formula used for calculation:

\[ L = \frac{20000W}{W} \]

Where:
- **L** = Lineal feet covered by one ton of material
- **R** = Rate of spread in lbs per 50 Yd
- **W** = Width of spread in feet
### TABLE XV-25
CUBIC YARDS OF MATERIAL REQUIRED FOR VARIOUS WIDTHS AND DEPTHS PER 100 LINEAR FEET AND PER MILE

<table>
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<th>Per Mile</th>
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</thead>
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<tr>
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<td>0.926</td>
</tr>
<tr>
<td>4</td>
<td>1.23</td>
<td>1.235</td>
</tr>
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<td>5</td>
<td>1.54</td>
<td>1.555</td>
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<td>1.85</td>
<td>1.869</td>
</tr>
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<td>7</td>
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<td>2.183</td>
</tr>
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<td>8</td>
<td>2.47</td>
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<tr>
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<td>3.09</td>
<td>3.012</td>
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### Depth—Inches

<table>
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<th>Per 100 Linear Feet</th>
<th>Per Mile</th>
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<td>0.31</td>
<td>0.3086</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>10</td>
<td>3.09</td>
<td>3.012</td>
</tr>
</tbody>
</table>

Note: Formulas used for calculation:

- **Per 100 Lin Ft:** \( q = \left( \frac{D}{36} \right) \left( \frac{W}{3} \right) \left( \frac{100}{3} \right) = 0.3086DW \)
- **Per Mile:** \( q = \left( \frac{D}{36} \right) \left( \frac{W}{3} \right) \left( \frac{5280}{3} \right) = 16.2963DW \)

Where:
- \( q \) = Quantity of material in cubic yards
- \( D \) = Depth in inches
- \( W \) = Width in feet
TABLE XV-26
SPECIFIC GRAVITY AND DENSITY
OF
MISCELLANEOUS SOLIDS AND LIQUIDS

Important Note

The specific gravity and density of most materials included in this table will vary through a range of values. Accordingly, ranges are indicated. Such ranges, however, are not necessarily inclusive as values will occasionally be encountered which will fall outside the indicated range.

Where solids are concerned, the specific gravity and density shown are for the material in solid form. To determine the density or unit weight of the material in crushed or granular form, it is also necessary to know the void content which, in turn, depends upon the gradation and degree of compaction of such materials. Knowing the void content and specific gravity, the bulk density or unit weight of the material in crushed or granular form may be obtained from Table XV-19.

It is preferable to determine both the specific gravity and the void content by appropriate test. The data provided below should therefore be used only for estimating purposes.

Specific Gravities and Densities of Miscellaneous Solid and Liquid Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Sp Gr</th>
<th>Weight lbs/ft³</th>
</tr>
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<tbody>
<tr>
<td>Alcohol, ethyl, pure</td>
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</tr>
<tr>
<td>Aluminum</td>
<td>2.53-2.80</td>
<td>159-175</td>
</tr>
<tr>
<td>Aluminum oxide</td>
<td>2.95-3.00</td>
<td>159-175</td>
</tr>
<tr>
<td>Asbestos</td>
<td>2.1-2.8</td>
<td>131-175</td>
</tr>
<tr>
<td>Asbestos paper</td>
<td>2.6-3.0</td>
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<tr>
<td>Asbestos sheet</td>
<td>2.6-3.0</td>
<td>130-220</td>
</tr>
<tr>
<td>Asphalt cement</td>
<td>0.99-1.04</td>
<td>61.8-64.9</td>
</tr>
<tr>
<td>Asphalt, liquid</td>
<td>0.92-1.01</td>
<td>57.4-63.0</td>
</tr>
<tr>
<td>Asphalt, natural</td>
<td>1.00-1.42</td>
<td>62.4-88.6</td>
</tr>
<tr>
<td>Basalt</td>
<td>2.7-3.2</td>
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<td>Benzene</td>
<td>0.73-0.75</td>
<td>45.6-46.8</td>
</tr>
<tr>
<td>Brass</td>
<td>8.4-8.7</td>
<td>524-543</td>
</tr>
<tr>
<td>Brick, building</td>
<td>1.4-1.9</td>
<td>87-119</td>
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<tr>
<td>Brick, paving</td>
<td>1.8-2.3</td>
<td>112-114</td>
</tr>
<tr>
<td>Bronze</td>
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<tr>
<td>Calcium carbonate, pure</td>
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<td>Calcium chloride (anhydrous)</td>
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<td>Carbon black</td>
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<td>Carbon disulphide</td>
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<tr>
<td>Carbon tetrachloride</td>
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<tr>
<td>Cement, portland</td>
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<td>Cement, portland, loose</td>
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<td>Cement mortar, portland</td>
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<td>Cinder</td>
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<td>Clay</td>
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<td>Coal</td>
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<td>75-93</td>
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<td>Concrete, asphalt</td>
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<td>135-155</td>
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<tr>
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<td>Cork</td>
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<tr>
<td>Creosote</td>
<td>1.03-1.08</td>
<td>64.3-67.4</td>
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<tr>
<td>Dolomite</td>
<td>2.8-2.9</td>
<td>174-181</td>
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<tr>
<td>Earth, loamy, dry</td>
<td>2.3-2.7</td>
<td>156-168</td>
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--- 370 ---

TABLE XV-26—(Continued)
SPECIFIC GRAVITY AND DENSITY
OF
MISCELLANEOUS SOLIDS AND LIQUIDS

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<th>Material</th>
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<th>Weight lbs/ft³</th>
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<tr>
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<tr>
<td>Graphite</td>
<td>2.4-2.8</td>
<td>150-158</td>
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<td>Granite</td>
<td>2.6-2.9</td>
<td>162-181</td>
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<td>2.1-2.7</td>
<td>143-168</td>
</tr>
<tr>
<td>Gravel</td>
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<td>143-168</td>
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<tr>
<td>Gypsum, calcined</td>
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</tr>
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<td>Ice</td>
<td>1.08-0.92</td>
<td>55-58</td>
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<tr>
<td>Iron, cast, pig</td>
<td>7.2</td>
<td>450</td>
</tr>
<tr>
<td>Iron, wrought</td>
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<td>474-493</td>
</tr>
<tr>
<td>Kerosene</td>
<td>0.78-0.82</td>
<td>48.7-51.2</td>
</tr>
<tr>
<td>Lead</td>
<td>11.54</td>
<td>707.9</td>
</tr>
<tr>
<td>Leather</td>
<td>0.88-1.02</td>
<td>53-64</td>
</tr>
<tr>
<td>Limestone</td>
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</tr>
<tr>
<td>Lime, quick, calcium oxide</td>
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<td>Lime, hydrated or slaked</td>
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<td>Lignite</td>
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<td>53.7-58.7</td>
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<tr>
<td>Mercury at 20°C</td>
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<td>845.65</td>
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<tr>
<td>Mica, muscovite</td>
<td>2.7-3.1</td>
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<tr>
<td>Naphtha, petroleum ether</td>
<td>0.61-0.66</td>
<td>39.3-41.2</td>
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<tr>
<td>Paraffin wax</td>
<td>0.85-0.95</td>
<td>53.0-59.3</td>
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<tr>
<td>Penet</td>
<td>0.91-1.04</td>
<td>56.8-64.9</td>
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<td>Petroleum</td>
<td>1.07-1.15</td>
<td>67-72</td>
</tr>
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<td>Pitch</td>
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<td>156-175</td>
</tr>
<tr>
<td>Quartz, flint</td>
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<td>125-168</td>
</tr>
<tr>
<td>Rubber, linseed</td>
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<td>Salt (sodium chloride)</td>
<td>2.16</td>
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<td>Sunburst</td>
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</tr>
<tr>
<td>Slate</td>
<td>2.6-2.9</td>
<td>162-181</td>
</tr>
<tr>
<td>Stag, granulated</td>
<td>1.4-1.6</td>
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<td>Stag, blast furnace</td>
<td>2.0-2.5</td>
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<td>487-493</td>
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<tr>
<td>Tar</td>
<td>0.93-1.25</td>
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<tr>
<td>Timber (air dry)</td>
<td>0.48-0.55</td>
<td>30-34</td>
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<tr>
<td>Fir, Douglas</td>
<td>0.74</td>
<td>46.2</td>
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<tr>
<td>Pines, Southern</td>
<td>0.61-0.67</td>
<td>38-42</td>
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<tr>
<td>Redwood, California</td>
<td>0.42</td>
<td>26.3</td>
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<tr>
<td>Trap Rock</td>
<td>2.7-3.2</td>
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<tr>
<td>Water, distilled, 39.2°F (+4°C)</td>
<td>1.00</td>
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<tr>
<td>Water, sea</td>
<td>1.02-1.04</td>
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### TABLE XV-27
CONVERSION OF LINEAR MEASUREMENTS
FEET TO MILES AND MILES TO FEET

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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<td>0.00028</td>
<td>0.00057</td>
<td>0.00075</td>
<td>0.00095</td>
<td>0.00113</td>
<td>0.00133</td>
<td>0.00152</td>
<td>0.00171</td>
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<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
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<tr>
<td>Feet</td>
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<td>0.00757</td>
<td>0.00947</td>
<td>0.01136</td>
<td>0.01325</td>
<td>0.01515</td>
<td>0.01705</td>
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<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
<td>800</td>
<td>900</td>
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<td>0.06256</td>
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<td>Feet</td>
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<td>2000</td>
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<td>4000</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
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<td>6.24722</td>
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### TABLE XV-28
CONVERSION OF LINEAR MEASUREMENTS
DECIMALS OF AN INCH FOR EACH 1/64 INCH

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<th>Fraction</th>
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<th>Decimal</th>
<th>Millimeters (approx.)</th>
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<td>0.397</td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>0.0625</td>
<td>1.588</td>
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<td>5</td>
<td>0.078125</td>
<td>1.984</td>
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</table>

<table>
<thead>
<tr>
<th>Fraction</th>
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<th>Millimeters (approx.)</th>
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<tr>
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<td>2/3</td>
<td>0.0625</td>
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<td>6</td>
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<td>0.125</td>
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<td>7/16</td>
<td>0.15625</td>
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<td>4.763</td>
<td>48</td>
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<tr>
<td>9/16</td>
<td>0.21875</td>
<td>5.556</td>
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<td>6.350</td>
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<td>0.4375</td>
<td>11.113</td>
<td>144</td>
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<tr>
<td>3/4</td>
<td>0.46875</td>
<td>11.906</td>
<td>156</td>
</tr>
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<td>31/32</td>
<td>0.500</td>
<td>12.700</td>
<td>168</td>
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</table>
### TABLE XV-29 (Continued)

CONVERSION OF LINEAR MEASUREMENTS
DECIMALS OF A FOOT FOR EACH ⅛ INCH TO 12 INCHES

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<tr>
<th>Inch</th>
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<th>1°</th>
<th>2°</th>
<th>3°</th>
<th>4°</th>
<th>5°</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>0</td>
<td>0.833</td>
<td>1.667</td>
<td>2.500</td>
<td>3.333</td>
<td>4.167</td>
</tr>
<tr>
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<td>0.0859</td>
<td>0.1693</td>
<td>0.2526</td>
<td>0.3359</td>
<td>0.4193</td>
</tr>
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<td>1/8</td>
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<td>0.0885</td>
<td>0.1719</td>
<td>0.2552</td>
<td>0.3385</td>
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<td>1.441</td>
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<td>1.823</td>
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<td>2.341</td>
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<tr>
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<td>0.719</td>
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<td>2.150</td>
<td>2.341</td>
<td>2.532</td>
</tr>
<tr>
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<td>0.833</td>
<td>2.085</td>
<td>2.276</td>
<td>2.467</td>
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<td>3.750</td>
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<td>4.332</td>
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<td>4.333</td>
<td>4.666</td>
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### TABLE XV-29 (Continued)

CONVERSION OF LINEAR MEASUREMENTS
DECIMALS OF A FOOT FOR EACH ⅛ INCH TO 12 INCHES

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<tr>
<th>Inch</th>
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<th>2°</th>
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<th>4°</th>
<th>5°</th>
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<td>0.667</td>
<td>0.750</td>
<td>0.833</td>
<td>0.917</td>
</tr>
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<td>0.833</td>
<td>0.917</td>
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<td>1.083</td>
<td>1.167</td>
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<td>1.333</td>
<td>1.417</td>
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<td>1.583</td>
<td>1.667</td>
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<td>1.833</td>
<td>1.917</td>
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<td>2.333</td>
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</tr>
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<td>2.500</td>
<td>2.583</td>
<td>2.667</td>
<td>2.750</td>
<td>2.833</td>
<td>2.917</td>
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<th>1°</th>
<th>2°</th>
<th>3°</th>
<th>4°</th>
<th>5°</th>
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<tr>
<td>1</td>
<td>1.000</td>
<td>1.188</td>
<td>1.375</td>
<td>1.562</td>
<td>1.750</td>
<td>1.937</td>
</tr>
<tr>
<td>1/2</td>
<td>1.500</td>
<td>1.688</td>
<td>1.875</td>
<td>2.062</td>
<td>2.250</td>
<td>2.437</td>
</tr>
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<td>2.000</td>
<td>2.188</td>
<td>2.375</td>
<td>2.562</td>
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<td>2.937</td>
</tr>
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<td>2.688</td>
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<td>3.000</td>
<td>3.188</td>
<td>3.375</td>
<td>3.562</td>
<td>3.750</td>
<td>3.937</td>
</tr>
<tr>
<td>1</td>
<td>3.500</td>
<td>3.688</td>
<td>3.875</td>
<td>4.062</td>
<td>4.250</td>
<td>4.437</td>
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### Table XV-30
CONVERSION FACTORS—LENGTH MEASUREMENTS

<table>
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<tr>
<th>Units</th>
<th>Inches</th>
<th>Feet</th>
<th>Yards</th>
<th>Rods</th>
<th>Miles</th>
<th>Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Inch</td>
<td>1</td>
<td>0.08333</td>
<td>0.027778</td>
<td>0.005051</td>
<td>0.0000157828</td>
<td>0.0254</td>
</tr>
<tr>
<td>1 Foot</td>
<td>12</td>
<td>1</td>
<td>0.33333</td>
<td>0.0666666</td>
<td>0.000068182</td>
<td>0.0914402</td>
</tr>
<tr>
<td>1 Yard</td>
<td>36</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0.181818</td>
<td>5.0299216</td>
</tr>
<tr>
<td>1 Rod (Surveyor’s Measure)</td>
<td>198</td>
<td>16.5</td>
<td>5.5</td>
<td>1</td>
<td>0.092105</td>
<td>5.0299216</td>
</tr>
<tr>
<td>1 Mile (U.S. Statute)</td>
<td>63360</td>
<td>5280</td>
<td>1760</td>
<td>320</td>
<td>0.199838</td>
<td>1.099347</td>
</tr>
<tr>
<td>1 Meter</td>
<td>39.37</td>
<td>3.280833</td>
<td>1.093611</td>
<td>0.199838</td>
<td>0.000067137</td>
<td>0.201168</td>
</tr>
<tr>
<td>1 Link</td>
<td>7.92</td>
<td>0.66</td>
<td>0.22</td>
<td>0.04</td>
<td>0.0199944</td>
<td>0.00125</td>
</tr>
<tr>
<td>1 Chain (Surveyor’s)</td>
<td>792</td>
<td>66</td>
<td>22</td>
<td>4</td>
<td>0.0199944</td>
<td>0.00125</td>
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<tr>
<td>1 Statute</td>
<td>1200</td>
<td>100</td>
<td>33.333</td>
<td>6.60606</td>
<td>0.0199944</td>
<td>0.00125</td>
</tr>
<tr>
<td>1 Furlong</td>
<td>7920</td>
<td>660</td>
<td>220</td>
<td>46</td>
<td>0.0199944</td>
<td>0.00125</td>
</tr>
<tr>
<td>1 Mil (Nautical)</td>
<td>79213</td>
<td>6761.03</td>
<td>2025.366</td>
<td>318.248</td>
<td>1.15078</td>
<td>0.01988</td>
</tr>
<tr>
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<td>0.03937</td>
<td>0.003281</td>
<td>0.0001094</td>
<td>0.0000199</td>
<td>—</td>
<td>0.0031</td>
</tr>
<tr>
<td>1 Centimeter</td>
<td>0.3937</td>
<td>0.032808</td>
<td>0.010936</td>
<td>0.001988</td>
<td>—</td>
<td>0.01</td>
</tr>
<tr>
<td>1 Kilometer</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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### Table XV-31
CONVERSION FACTORS—AREA MEASUREMENTS

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<thead>
<tr>
<th>Units</th>
<th>Square Inches</th>
<th>Square Feet</th>
<th>Square Yards</th>
<th>Square Rods</th>
<th>Acres</th>
<th>Square Miles</th>
<th>Square Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Square Inch</td>
<td>1</td>
<td>0.006944</td>
<td>0.0007716</td>
<td>0.0036731</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 Square Foot</td>
<td>144</td>
<td>1</td>
<td>0.11111</td>
<td>0.0333358</td>
<td>0.0002046</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 Square Yard</td>
<td>1296</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>0.00625</td>
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<td>—</td>
</tr>
<tr>
<td>1 Square Rod</td>
<td>39204</td>
<td>322.5</td>
<td>32.25</td>
<td>1</td>
<td>1.0</td>
<td>0.01525</td>
<td>25.29295</td>
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<tr>
<td>1 Acre</td>
<td>43560</td>
<td>4440</td>
<td>484</td>
<td>160</td>
<td>1.640</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 Square Mile</td>
<td>627264</td>
<td>6761.03</td>
<td>11959.85</td>
<td>39536.7</td>
<td>2471044</td>
<td>0.003861</td>
<td>10000000</td>
</tr>
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<td>1 Square Centimeter</td>
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<td>0.0010764</td>
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<td>—</td>
</tr>
<tr>
<td>1 Hectare</td>
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<td>119598.5</td>
<td>39536.7</td>
<td>2471044</td>
<td>0.3861006</td>
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</tr>
<tr>
<td>1 Square Kilometer</td>
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<td>—</td>
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<td>—</td>
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### TABLE XV.32
CONVERSION FACTORS—VOLUME MEASUREMENTS

<table>
<thead>
<tr>
<th>Units</th>
<th>Cubic Inches</th>
<th>Cubic Feet</th>
<th>Cubic Yards</th>
<th>Pints (Liquid)</th>
<th>Quarts (Liquid)</th>
<th>Gallons (U.S.)</th>
<th>Liters (1000 cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cubic Inch</td>
<td>1</td>
<td>0.000579</td>
<td>0.0000214</td>
<td>0.034632</td>
<td>0.017316</td>
<td>0.004329</td>
<td>0.0016387</td>
</tr>
<tr>
<td>1 Cubic Foot</td>
<td>1728</td>
<td>1</td>
<td>0.037037</td>
<td>59.844</td>
<td>29.922</td>
<td>7.4805</td>
<td>28.3125</td>
</tr>
<tr>
<td>1 Cubic Yard</td>
<td>46656</td>
<td>27</td>
<td>1</td>
<td>1015.8</td>
<td>807.9</td>
<td>201.972</td>
<td>764.34</td>
</tr>
<tr>
<td>1 Pint (Liquid)</td>
<td>28.875</td>
<td>0.016710</td>
<td>0.000619</td>
<td>0.5</td>
<td>0.25</td>
<td>0.125</td>
<td>0.071668</td>
</tr>
<tr>
<td>1 Quart (Liquid)</td>
<td>57.75</td>
<td>0.033420</td>
<td>0.001238</td>
<td>2</td>
<td>1</td>
<td>0.5</td>
<td>0.946333</td>
</tr>
<tr>
<td>1 Gallon (U.S.)</td>
<td>231</td>
<td>1.336805</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>0.25</td>
<td>3.78533</td>
</tr>
<tr>
<td>1 Liter (1000 cc)</td>
<td>61.025</td>
<td>0.035316</td>
<td>0.001308</td>
<td>2.13326</td>
<td>1.05682</td>
<td>0.264178</td>
<td>1</td>
</tr>
<tr>
<td>1 Gill</td>
<td>7.21875</td>
<td>0.004177</td>
<td>0.000155</td>
<td>0.25</td>
<td>0.125</td>
<td>0.03125</td>
<td>0.118922</td>
</tr>
<tr>
<td>1 Pint (Dry)</td>
<td>33.6023</td>
<td>0.19445</td>
<td>0.007020</td>
<td>1.13547</td>
<td>0.58123</td>
<td>0.15456</td>
<td>0.750599</td>
</tr>
<tr>
<td>1 Quart (Dry)</td>
<td>67.20625</td>
<td>0.38889</td>
<td>0.001440</td>
<td>2.37270</td>
<td>1.16564</td>
<td>0.290912</td>
<td>1.10120</td>
</tr>
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<td>1 Quart (Imperial)</td>
<td>69.3562</td>
<td>0.40133</td>
<td>0.001486</td>
<td>2.4015</td>
<td>1.209053</td>
<td>0.302238</td>
<td>1.13859</td>
</tr>
<tr>
<td>1 Gallon (Imperial)</td>
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<td>8</td>
<td>4</td>
<td>1.209053</td>
<td>1.209053</td>
<td>4.34609</td>
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<td>0.011523</td>
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<td>9.309172</td>
<td>2.372794</td>
<td>8.809386</td>
</tr>
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<td>1 Bushel (US)</td>
<td>2159.42</td>
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<td>0.46089</td>
<td>74.47241</td>
<td>37.23670</td>
<td>9.30927</td>
<td>35.238329</td>
</tr>
<tr>
<td>1 Board Foot</td>
<td>144</td>
<td>1.08333</td>
<td>0.003086</td>
<td>4.987012</td>
<td>2.493506</td>
<td>0.623376</td>
<td>2.3597</td>
</tr>
<tr>
<td>1 Cord</td>
<td>2711.84</td>
<td>17.8</td>
<td>0.74074</td>
<td>76.66051</td>
<td>38.80025</td>
<td>8.95506</td>
<td>36.2448</td>
</tr>
<tr>
<td>1 Barrel (Petroleum)</td>
<td>6701.975</td>
<td>56.14569</td>
<td>336</td>
<td>168</td>
<td>42</td>
<td>158.9839</td>
<td>119.237895</td>
</tr>
<tr>
<td>1 Barrel (US. Liquid)</td>
<td>7276.370</td>
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<td>115.96</td>
<td>232</td>
<td>126</td>
<td>31.5</td>
<td>99.9973</td>
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<td>1 Cubic Meter</td>
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<td>61.0238</td>
<td>1.093644</td>
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<td>105.67</td>
<td>264.178</td>
<td>999.973</td>
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</table>

### TABLE XV.33
CONVERSION FACTORS—WEIGHT MEASUREMENTS

<table>
<thead>
<tr>
<th>Units</th>
<th>Ounces</th>
<th>Pounds</th>
<th>Tons (Short)</th>
<th>Tons (Long)</th>
<th>Kilograms</th>
<th>Tons (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ounce</td>
<td>1</td>
<td>0.0625</td>
<td>—</td>
<td>—</td>
<td>0.0005</td>
<td>—</td>
</tr>
<tr>
<td>1 Pound</td>
<td>16</td>
<td>1</td>
<td>0.0005</td>
<td>0.0004644</td>
<td>0.0005</td>
<td>0.005</td>
</tr>
<tr>
<td>1 Ton (Short)</td>
<td>32000</td>
<td>2000</td>
<td>0.892857</td>
<td>0.4435924</td>
<td>0.907185</td>
<td>0.4435924</td>
</tr>
<tr>
<td>1 Ton (Long)</td>
<td>35840</td>
<td>2240</td>
<td>1.12</td>
<td>0.4893927</td>
<td>1.01647</td>
<td>0.4893927</td>
</tr>
<tr>
<td>1 Kilogram</td>
<td>35.2736</td>
<td>100</td>
<td>0.001023</td>
<td>0.00099824</td>
<td>0.001023</td>
<td>0.00099824</td>
</tr>
<tr>
<td>1 Hundredweight (Short)</td>
<td>1600</td>
<td>100</td>
<td>0.05</td>
<td>0.044643</td>
<td>0.05</td>
<td>0.044643</td>
</tr>
<tr>
<td>1 Hundredweight (Long)</td>
<td>1793</td>
<td>112</td>
<td>0.0356</td>
<td>0.018022</td>
<td>0.0356</td>
<td>0.018022</td>
</tr>
<tr>
<td>1 Gram</td>
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<td>0.0011015</td>
<td>0.0005307</td>
<td>0.0011015</td>
<td>0.0005307</td>
</tr>
<tr>
<td>1 Milligram</td>
<td>0.0352739</td>
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<td>0.0009901</td>
<td>0.002004</td>
<td>0.0009901</td>
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### TABLE XV.34
CONVERSION FACTORS
MISCELLANEOUS

<table>
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<th>Multiply</th>
<th>By</th>
<th>To Obtain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds per foot</td>
<td>1.048816</td>
<td>Kilograms per meter</td>
</tr>
<tr>
<td>Pounds per square foot</td>
<td>4.44822</td>
<td>Kilograms per square meter</td>
</tr>
<tr>
<td>Pounds per square inch</td>
<td>0.07031</td>
<td>Kilograms per square cm.</td>
</tr>
<tr>
<td>Pounds per cubic foot</td>
<td>0.000907031</td>
<td>Kilograms per cubic meter</td>
</tr>
<tr>
<td>Radians</td>
<td>16.0184</td>
<td>Degrees, angular</td>
</tr>
<tr>
<td>Horsepower</td>
<td>32.7292</td>
<td>Ft-lbs per second</td>
</tr>
<tr>
<td>Horsepower</td>
<td>254.4</td>
<td>B.T.U.'s per hour</td>
</tr>
<tr>
<td>B.T.U.</td>
<td>231.98</td>
<td>Watts</td>
</tr>
<tr>
<td>Feet per second</td>
<td>777.98</td>
<td>Calories, gram</td>
</tr>
<tr>
<td>Miles per hour</td>
<td>0.68182</td>
<td>Ft-lbs</td>
</tr>
<tr>
<td>Pounds</td>
<td>1.46667</td>
<td>Miles per hour</td>
</tr>
<tr>
<td>Kilograms</td>
<td>980.665</td>
<td>Feet per minute</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>1.0233</td>
<td>Feet per second</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>14.697</td>
<td>lysnes</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>29.921</td>
<td>Kilograms per square cm.</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>0.76</td>
<td>Inches of mercury (0°C, at sea level)</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>33.9</td>
<td>Meters of mercury (0°C, at sea level)</td>
</tr>
<tr>
<td>Pounds of water per minute</td>
<td>0.016021</td>
<td>Cubic feet per minute</td>
</tr>
<tr>
<td>Cubic feet per minute</td>
<td>0.12468</td>
<td>Gallons per second</td>
</tr>
<tr>
<td>Feet</td>
<td>50.0</td>
<td>Feet</td>
</tr>
<tr>
<td>Degrees per foot</td>
<td>0.00057261</td>
<td>Radial per centimeter</td>
</tr>
<tr>
<td>Cubic centimeters of mercury at 20°C</td>
<td>5.34</td>
<td>Inches of water (at 20°C)</td>
</tr>
</tbody>
</table>

### TABLE XV.35
DENSITY AND VISCOSITY OF WATER
AT VARIOUS TEMPERATURES

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Density gm/ml</th>
<th>Density in lbs/cu ft</th>
<th>Viscosity in Centipoises</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>+14</td>
<td>0.99815</td>
<td>62.3128</td>
</tr>
<tr>
<td>-5</td>
<td>23</td>
<td>0.99930</td>
<td>62.3846</td>
</tr>
<tr>
<td>0</td>
<td>32</td>
<td>0.99987</td>
<td>62.4201</td>
</tr>
<tr>
<td>+14</td>
<td>39.20</td>
<td>1.00000</td>
<td>62.4283</td>
</tr>
<tr>
<td>5</td>
<td>41</td>
<td>0.99999</td>
<td>62.4276</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>0.99973</td>
<td>62.4114</td>
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<tr>
<td>15</td>
<td>59</td>
<td>0.99913</td>
<td>62.3739</td>
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<tr>
<td>20</td>
<td>68</td>
<td>0.99823</td>
<td>62.3178</td>
</tr>
<tr>
<td>20.2</td>
<td>68.36</td>
<td>0.99819</td>
<td>62.3153</td>
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<tr>
<td>25</td>
<td>77</td>
<td>0.99707</td>
<td>62.2453</td>
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<tr>
<td>30</td>
<td>86</td>
<td>0.99567</td>
<td>62.1579</td>
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<tr>
<td>35</td>
<td>95</td>
<td>0.99405</td>
<td>61.9574</td>
</tr>
<tr>
<td>40</td>
<td>104</td>
<td>0.99224</td>
<td>61.9438</td>
</tr>
<tr>
<td>45</td>
<td>113</td>
<td>0.99025</td>
<td>61.8196</td>
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<tr>
<td>50</td>
<td>122</td>
<td>0.98807</td>
<td>61.6835</td>
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<tr>
<td>55</td>
<td>131</td>
<td>0.98573</td>
<td>61.5374</td>
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<tr>
<td>60</td>
<td>140</td>
<td>0.98324</td>
<td>61.3820</td>
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<tr>
<td>65</td>
<td>149</td>
<td>0.98039</td>
<td>61.2165</td>
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<td>70</td>
<td>158</td>
<td>0.97781</td>
<td>61.0430</td>
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<td>75</td>
<td>167</td>
<td>0.97489</td>
<td>60.8607</td>
</tr>
<tr>
<td>80</td>
<td>176</td>
<td>0.97183</td>
<td>60.6697</td>
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<td>85</td>
<td>185</td>
<td>0.96865</td>
<td>60.4711</td>
</tr>
<tr>
<td>90</td>
<td>194</td>
<td>0.96534</td>
<td>60.2645</td>
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<tr>
<td>95</td>
<td>203</td>
<td>0.96172</td>
<td>60.0510</td>
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<tr>
<td>100</td>
<td>212</td>
<td>0.95838</td>
<td>59.8300</td>
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</table>
### Table XV-36

#### AREAS OF PLANE FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Formula</th>
<th>Example</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Square</strong></td>
<td>Diagonal = $d = 2a \sqrt{2}$</td>
<td>$a = 6$</td>
<td>$6 \times 6 = 36$</td>
</tr>
<tr>
<td></td>
<td>Area = $a^2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Example, $a = 6$; $b = 3$; Area = $(6)^2 = 36$ Ans.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rectangle and Parallelogram</strong></td>
<td>Area = $ab$ or $b \sqrt{a^2 - b^2}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trapezoid</strong></td>
<td>$a$, $b$, $c$, $d$</td>
<td>$a = 4$</td>
<td>$4 \times 2 = 8$</td>
</tr>
<tr>
<td></td>
<td>Area = $\frac{1}{2}(a + b)(S - b)$</td>
<td>$b = 2$</td>
<td>$2 \times 2 = 4$</td>
</tr>
<tr>
<td><strong>Trapezium</strong></td>
<td>$a$, $b$, $c$, $d$</td>
<td>$c = 3$</td>
<td>$3 \times 3 = 9$</td>
</tr>
<tr>
<td></td>
<td>Area = $\frac{1}{2}(a + b)(S - b)$</td>
<td>$d = 4$</td>
<td>$4 \times 4 = 16$</td>
</tr>
<tr>
<td><strong>Triangles</strong></td>
<td>Both formulae apply to both figures</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regular Polygons</strong></td>
<td>$S = \frac{\sum a}{n}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table XV-36 (continued)

#### Circle

<table>
<thead>
<tr>
<th>Circle Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A = \frac{d^2}{4}$</td>
<td>Area = $\frac{d^2}{4}$</td>
</tr>
<tr>
<td>$A = \pi r^2$</td>
<td>Area = $\pi r^2$</td>
</tr>
</tbody>
</table>

#### Segment

<table>
<thead>
<tr>
<th>Segment Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A = \frac{1}{2}\theta r^2$</td>
<td>Area = $\frac{1}{2}\theta r^2$</td>
</tr>
</tbody>
</table>

#### Sector

<table>
<thead>
<tr>
<th>Sector Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A = \frac{1}{2}\theta r^2$</td>
<td>Area = $\frac{1}{2}\theta r^2$</td>
</tr>
</tbody>
</table>
### Table XV-36 (continued)

**Spandrel**

Area: $0.14142 = 0.1673 k^2$

Example, $r = 3$

Area: $0.1414 \times 3^2 = 1.9314$, Ans.

**Parabola**

$L = \text{length of curved line} = \text{periphery} = ^{2}

L = \frac{8}{3} \sqrt{(c + e)} + 0.0699 \times \log(\sqrt{c} + \sqrt{c + e})

in which $c = \left(\frac{41}{3}\right)^3$

Area: $\frac{8}{3} h$

Example, $e = 3$, $h = 4$

Area: $\frac{8}{3} \times 3 \times 4 = 8$, Ans.

**Ellipse**

Area: $\pi ab = 3.1416 ab$

Circum. = $\pi (a + b) \frac{b - a}{b + a}$

(An approximation)

Example, $a = 3$, $b = 4$

Area: $3.1416 \times 3 \times 4 = 37.6992$, Ans.

Circum. = $3.1416(4 + 3)\frac{1 - \frac{3}{2}}{b + a}$

Area: $3.1416 \times 7 \times 3.1416 = 82.13$, Ans.

### Table XV-37 (continued)

**Rectangular Prism**

$V = abh$

$T = 2(ab + ah + bh)$

$S = 2(ab + ah + bh)$

$d = \sqrt{a^2 + b^2 + h^2}$

**Prism or Cylinder, Right or Oblique, Parallel Ends**

$V = Ah$

$S = Pl$

$T = Pl + 2B$

(Note $A = B$, $P = P_a$ and $l = h$ for right cylinders and prisms)

**Cylinder, Right or Oblique, Circular or Otherwise, Parallel Ends**

$V = Bh$ (Right Cylinder)

$S = Ph$ (Right Cylinder)

$P = D$ (Oblique Cylinder)

$T = Ph + 2D$ (Oblique Cylinder)

$T = Ph + 2B$ (Oblique Cylinder)

**Frustrum of Prism or Cylinder**

$V = \frac{1}{3}h_1 (h_1 + h_2)$

**Pyramid or Cone, Right and Regular**

$V = \frac{1}{3} Bh$

$S = \frac{1}{2} S$

$T = \frac{1}{2} (b + B)$

**Pyramid or Cone, Right or Oblique, Regular or Irregular**

$V = \frac{1}{3} Bh$
Table XV-37 (continued)

Frustum of Pyramid or Cone, Right and Regular, Parallel Ends

\[ V = \frac{h}{3}(B_1 + B_2 + \sqrt{B_1 B_2}) \]
\[ S = \frac{1}{2}(P_1 + P_2) \]
\[ T = \frac{1}{2}(P_1 + P_2) + B_1 + B_2 \]
where: \( B_1 = \text{Area of Top} \)
\( P_T = \text{Perimeter of Top} \)

Frustum of Any Pyramid or Cone, Parallel Ends

\[ V = \frac{1}{3}h(B_1 + B_2 + \sqrt{B_1 B_2}) \]
where: \( B_1 = \text{Area of Top} \)

Wedge, Regular

\[ V = \frac{h}{6}(a + b)(a + b + c) \]

Sphere

\[ V = \frac{4}{3}\pi r^3 \]
\[ S = 4\pi r^2 \]

Spherical Sector

\[ S = \frac{1}{2}\pi r(2b + c) \]
\[ V = \frac{1}{3}\pi r^2 b \]

Spherical Segment

\[ S = 2\pi bh = \frac{2}{3}\pi(4a^3 + c^3) \]
\[ V = \frac{1}{3}\pi bh(2r - b) \]
\[ = \frac{1}{24}\pi h(3c^2 + 4d^2) \]

Table XV-37 (continued)

Spherical Zone

\[ S = 2\pi rb \]
\[ V = \frac{1}{3}\pi r^2(8a^2 + 5b^2 + 4a^3) \]

Circular Ring

\[ S = 2\pi^2 Rr \]
\[ V = \frac{4}{3}\pi^2 Rr^3 \]

Ellipsoid

\[ V = \frac{1}{4}\pi^2abh \]

Paraboloid

\[ V = \frac{1}{8}\pi^2 ah^3 \]
### TABLE XV-38

**TRIGONOMETRIC RELATIONS AND SOLUTIONS OF RIGHT ANGLE TRIANGLES**

As shown in the illustration, the sides of the right angled triangle are designated $a$, $b$, and $c$. The angles opposite each of these sides are designated $A$, $B$, and $C$ respectively.

Angle $A$, opposite the hypotenuse $c$ is the right angle and is therefore always one of the known quantities.

<table>
<thead>
<tr>
<th>Sides and Angles Known</th>
<th>Formulas for Sides and Angles to be Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sides $a$ and $b$</td>
<td>$c = \sqrt{a^2 - b^2}$, ( \sin B = \frac{b}{c} ), $C = 90^\circ - B$</td>
</tr>
<tr>
<td>Sides $a$ and $c$</td>
<td>$b = \sqrt{c^2 - a^2}$, ( \sin B = \frac{c}{a} ), $C = 90^\circ - B$</td>
</tr>
<tr>
<td>Sides $b$ and $c$</td>
<td>$a = \sqrt{b^2 + c^2}$, ( \tan C = \frac{b}{c} ), $C = 90^\circ - B$</td>
</tr>
<tr>
<td>Side $a$, angle $B$</td>
<td>$b = a \times \sin B$, ( c = a \times \cos B ), $C = 90^\circ - B$</td>
</tr>
<tr>
<td>Side $a$, angle $C$</td>
<td>$b = a \times \cos C$, ( c = a \times \sin C ), $B = 90^\circ - C$</td>
</tr>
<tr>
<td>Side $b$, angle $B$</td>
<td>$a = \frac{b}{\sin B}$, ( c = b \times \cos B ), $C = 90^\circ - B$</td>
</tr>
<tr>
<td>Side $b$, angle $C$</td>
<td>$a = \frac{b}{\cos C}$, ( c = b \times \sin C ), $B = 90^\circ - C$</td>
</tr>
<tr>
<td>Side $c$, angle $B$</td>
<td>$a = \frac{c}{\cos B}$, ( b = c \times \cos B ), $C = 90^\circ - B$</td>
</tr>
<tr>
<td>Side $c$, angle $C$</td>
<td>$a = \frac{c}{\sin C}$, ( b = c \times \sin C ), $B = 90^\circ - C$</td>
</tr>
</tbody>
</table>

### TABLE XV-39

**TRIGONOMETRIC FUNCTIONS**

<table>
<thead>
<tr>
<th>Angle</th>
<th>Sin</th>
<th>Cos</th>
<th>Tan</th>
<th>Angle</th>
<th>Sin</th>
<th>Cos</th>
<th>Tan</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>1.000</td>
<td>0.000</td>
<td>0.000</td>
<td>46.00</td>
<td>0.719</td>
<td>0.695</td>
<td>1.04</td>
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<tr>
<td>1.017</td>
<td>0.999</td>
<td>0.017</td>
<td>0.731</td>
<td>47.00</td>
<td>0.682</td>
<td>1.07</td>
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<tr>
<td>2.034</td>
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<td>0.034</td>
<td>0.743</td>
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<tr>
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<td>0.051</td>
<td>0.755</td>
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<td>0.656</td>
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<td>0.999</td>
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<tr>
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<td>0.902</td>
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<tr>
<td>19.323</td>
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<td>1.523</td>
<td>0.911</td>
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<tr>
<td>20.340</td>
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<td>1.640</td>
<td>0.920</td>
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<td>0.929</td>
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<td>22.374</td>
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<td>1.874</td>
<td>0.938</td>
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<td>0.947</td>
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<td>0.340</td>
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<td>24.408</td>
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<td>0.957</td>
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<td>0.323</td>
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<td>0.966</td>
<td>71.00</td>
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<td>0.289</td>
<td>2.44</td>
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<tr>
<td>27.459</td>
<td>0.999</td>
<td>2.459</td>
<td>0.984</td>
<td>73.00</td>
<td>0.272</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>28.476</td>
<td>0.999</td>
<td>2.576</td>
<td>0.993</td>
<td>74.00</td>
<td>0.255</td>
<td>2.56</td>
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</tr>
<tr>
<td>29.493</td>
<td>0.999</td>
<td>2.693</td>
<td>1.002</td>
<td>75.00</td>
<td>0.238</td>
<td>2.62</td>
<td></td>
</tr>
<tr>
<td>30.510</td>
<td>0.999</td>
<td>2.810</td>
<td>1.011</td>
<td>76.00</td>
<td>0.221</td>
<td>2.68</td>
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</tr>
<tr>
<td>31.527</td>
<td>0.999</td>
<td>2.927</td>
<td>1.020</td>
<td>77.00</td>
<td>0.204</td>
<td>2.74</td>
<td></td>
</tr>
<tr>
<td>32.544</td>
<td>0.999</td>
<td>3.044</td>
<td>1.029</td>
<td>78.00</td>
<td>0.187</td>
<td>2.80</td>
<td></td>
</tr>
<tr>
<td>33.561</td>
<td>0.999</td>
<td>3.161</td>
<td>1.038</td>
<td>79.00</td>
<td>0.170</td>
<td>2.86</td>
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</tr>
<tr>
<td>34.578</td>
<td>0.999</td>
<td>3.278</td>
<td>1.047</td>
<td>80.00</td>
<td>0.153</td>
<td>2.92</td>
<td></td>
</tr>
<tr>
<td>35.595</td>
<td>0.999</td>
<td>3.395</td>
<td>1.056</td>
<td>81.00</td>
<td>0.136</td>
<td>2.98</td>
<td></td>
</tr>
<tr>
<td>36.612</td>
<td>0.999</td>
<td>3.512</td>
<td>1.065</td>
<td>82.00</td>
<td>0.119</td>
<td>3.04</td>
<td></td>
</tr>
<tr>
<td>37.629</td>
<td>0.999</td>
<td>3.629</td>
<td>1.074</td>
<td>83.00</td>
<td>0.102</td>
<td>3.10</td>
<td></td>
</tr>
<tr>
<td>38.646</td>
<td>0.999</td>
<td>3.746</td>
<td>1.083</td>
<td>84.00</td>
<td>0.085</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>39.663</td>
<td>0.999</td>
<td>3.863</td>
<td>1.092</td>
<td>85.00</td>
<td>0.068</td>
<td>3.22</td>
<td></td>
</tr>
<tr>
<td>40.680</td>
<td>0.999</td>
<td>3.980</td>
<td>1.101</td>
<td>86.00</td>
<td>0.051</td>
<td>3.28</td>
<td></td>
</tr>
<tr>
<td>41.697</td>
<td>0.999</td>
<td>4.097</td>
<td>1.110</td>
<td>87.00</td>
<td>0.034</td>
<td>3.34</td>
<td></td>
</tr>
<tr>
<td>42.714</td>
<td>0.999</td>
<td>4.214</td>
<td>1.119</td>
<td>88.00</td>
<td>0.017</td>
<td>3.40</td>
<td></td>
</tr>
<tr>
<td>43.731</td>
<td>0.999</td>
<td>4.331</td>
<td>1.128</td>
<td>89.00</td>
<td>0.000</td>
<td>3.46</td>
<td></td>
</tr>
<tr>
<td>44.748</td>
<td>0.999</td>
<td>4.448</td>
<td>1.137</td>
<td>90.00</td>
<td>0.000</td>
<td>Infinity</td>
<td></td>
</tr>
</tbody>
</table>
# TABLE XV-40

**Asphalt Block Recommended Thicknesses for Typical Applications**

<table>
<thead>
<tr>
<th>Typical Applications</th>
<th>Thickness of Unit Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Floors</td>
<td>1 1/2&quot;, 2&quot; or 2 1/2&quot;</td>
</tr>
<tr>
<td>Warehouse, Baggage and Express Room Floors</td>
<td>1 1/2&quot; or 2&quot;</td>
</tr>
<tr>
<td>Traffic Aisles and Loading Platforms</td>
<td>1 1/2&quot; or 2&quot;</td>
</tr>
<tr>
<td>Piers and Decks</td>
<td>1 1/2&quot; or 2&quot;</td>
</tr>
<tr>
<td>Roof Decks—Parking or Storage</td>
<td>1 1/2&quot;</td>
</tr>
<tr>
<td>Roof Decks and Balconies—Recreational</td>
<td>1 1/2&quot; or 1 1/2&quot;</td>
</tr>
<tr>
<td>Airport, Hangars, Runways, Aprons</td>
<td>1 1/2&quot;, 2&quot; or 2 1/2&quot;</td>
</tr>
<tr>
<td>Ramps and Bridge Approaches</td>
<td>2 1/2&quot; or 3&quot;</td>
</tr>
<tr>
<td>Streets, Roads, Bridges, Viaducts</td>
<td>2 1/2&quot; or 3&quot;</td>
</tr>
<tr>
<td>Waterproofing Protection Courses</td>
<td>1 1/4&quot;</td>
</tr>
<tr>
<td>Estate, Residential and Institutional Drive-ways</td>
<td>2&quot; Hexagonal or Rectangular</td>
</tr>
<tr>
<td>Walks, Courts, Plazas and Terraces</td>
<td>2&quot; Hexagonal or Rectangular</td>
</tr>
</tbody>
</table>

---

# TABLE XV-41

**Asphalt Block Weight and Quantity Relationships**

<table>
<thead>
<tr>
<th>Size</th>
<th>Pounds per Block per Sq Ft</th>
<th>Pounds per Block per Sq Yd</th>
<th>Pounds per Thousand Blocks per Sq Yd</th>
<th>Net Tons per Thousand Blocks per Sq Yd</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>10.5</td>
<td>25.2</td>
<td>227.3</td>
<td>5.50</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>12.9</td>
<td>28.6</td>
<td>281.4</td>
<td>6.43</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>14.3</td>
<td>31.0</td>
<td>313.4</td>
<td>6.93</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>16.8</td>
<td>33.6</td>
<td>339.1</td>
<td>7.43</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>19.4</td>
<td>36.2</td>
<td>361.0</td>
<td>7.89</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>22.0</td>
<td>38.8</td>
<td>382.4</td>
<td>8.34</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>24.6</td>
<td>41.4</td>
<td>403.0</td>
<td>8.79</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>27.2</td>
<td>43.9</td>
<td>423.6</td>
<td>9.25</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>29.8</td>
<td>46.5</td>
<td>444.1</td>
<td>9.70</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>32.4</td>
<td>49.1</td>
<td>464.6</td>
<td>10.15</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>35.0</td>
<td>51.7</td>
<td>485.1</td>
<td>10.60</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>37.6</td>
<td>54.3</td>
<td>505.6</td>
<td>11.05</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>40.2</td>
<td>56.9</td>
<td>526.1</td>
<td>11.50</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>42.8</td>
<td>59.5</td>
<td>546.6</td>
<td>12.05</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>45.4</td>
<td>62.1</td>
<td>567.1</td>
<td>12.50</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>48.0</td>
<td>64.7</td>
<td>587.6</td>
<td>13.05</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>50.6</td>
<td>67.3</td>
<td>608.1</td>
<td>13.50</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>53.2</td>
<td>69.9</td>
<td>628.6</td>
<td>14.05</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>55.8</td>
<td>72.5</td>
<td>649.1</td>
<td>14.50</td>
</tr>
<tr>
<td>1 1/2&quot; x 2 1/2&quot;</td>
<td>58.4</td>
<td>75.0</td>
<td>669.6</td>
<td>15.05</td>
</tr>
</tbody>
</table>

Hexagonal Tiles

Square Tiles
### TABLE XV-42

**Requirements for U.S. Standard Testing Sieves and Approximate Equivalents of Square and Round Openings**

#### U.S. Standard Sieves

Standard Requirements for Certain Sizes

<table>
<thead>
<tr>
<th>Size of Sieve Designation</th>
<th>Sieve Opening</th>
<th>Permissible Variations in Average Opening, Percent</th>
<th>Permissible Variations in Maximum Opening, Percent</th>
<th>Wire Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mm. (Approximate Equivalents)</td>
<td>mm. (Approximate Equivalents)</td>
<td></td>
</tr>
<tr>
<td>3 in.</td>
<td>76.2</td>
<td>±2</td>
<td>±3</td>
<td>4.8 to 8.1</td>
</tr>
<tr>
<td>2½ in.</td>
<td>63.5</td>
<td>±2</td>
<td>±3</td>
<td>4.4 to 7.1</td>
</tr>
<tr>
<td>2 in.</td>
<td>50.8</td>
<td>±2</td>
<td>±3</td>
<td>4.1 to 6.2</td>
</tr>
<tr>
<td>1½ in.</td>
<td>38.1</td>
<td>±2</td>
<td>±3</td>
<td>3.7 to 5.3</td>
</tr>
<tr>
<td>1¼ in.</td>
<td>31.7</td>
<td>±2</td>
<td>±3</td>
<td>3.5 to 4.8</td>
</tr>
<tr>
<td>1 in.</td>
<td>25.4</td>
<td>±3</td>
<td>±5</td>
<td>3.1 to 4.5</td>
</tr>
<tr>
<td>¾ in.</td>
<td>19.1</td>
<td>±3</td>
<td>±5</td>
<td>2.9 to 3.9</td>
</tr>
<tr>
<td>½ in.</td>
<td>15.2</td>
<td>±3</td>
<td>±5</td>
<td>2.7 to 3.7</td>
</tr>
<tr>
<td>⅜ in.</td>
<td>12.7</td>
<td>±3</td>
<td>±5</td>
<td>2.5 to 3.5</td>
</tr>
<tr>
<td>No. 4</td>
<td>9.52</td>
<td>±3</td>
<td>±5</td>
<td>2.3 to 3.3</td>
</tr>
<tr>
<td>No. 8</td>
<td>6.35</td>
<td>±3</td>
<td>±5</td>
<td>2.1 to 2.9</td>
</tr>
<tr>
<td>No. 12</td>
<td>4.76</td>
<td>±3</td>
<td>±5</td>
<td>1.9 to 2.1</td>
</tr>
<tr>
<td>No. 20</td>
<td>3.50</td>
<td>±3</td>
<td>±5</td>
<td>1.7 to 1.9</td>
</tr>
<tr>
<td>No. 30</td>
<td>2.00</td>
<td>±5</td>
<td>±7</td>
<td>1.5 to 1.7</td>
</tr>
</tbody>
</table>

**Approximate Equivalents of Square and Round Openings**

<table>
<thead>
<tr>
<th>Hole Size (Inches)</th>
<th>Square</th>
<th>Round</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>⅜</td>
<td>3⅝</td>
</tr>
<tr>
<td>2½</td>
<td>⅛</td>
<td>3⅝</td>
</tr>
<tr>
<td>2</td>
<td>⅜</td>
<td>3⅝</td>
</tr>
<tr>
<td>1½</td>
<td>⅞</td>
<td>3⅝</td>
</tr>
<tr>
<td>1⅝</td>
<td>⅞</td>
<td>3⅝</td>
</tr>
<tr>
<td>1⅝</td>
<td>⅞</td>
<td>3⅝</td>
</tr>
</tbody>
</table>

**Example Calculations**

- No. 40: 0.42 in.
- No. 50: 0.297 in.
- No. 80: 0.177 in.
- No. 100: 0.149 in.
- No. 200: 0.074 in.
### TABLE XV-43
APPROXIMATE PROCEDURE FOR TRANSFORMING "PASSING-RETAINED" SPECIFICATION TO AN EQUIVALENT "TOTAL PERCENT PASSING" SPECIFICATION

<table>
<thead>
<tr>
<th>Assumed &quot;Passing- Retained&quot; Specification</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cumulative Percent Passing, Fine to Coarse Sizes</td>
<td>Cumulative Percent Retained, Course to Fine Sizes</td>
<td>Cumulative Percent Passing, Course to Fine Sizes</td>
<td>Equivalent Specification on &quot;Total Percent Passing&quot; Basis</td>
</tr>
<tr>
<td>Col. No. 1</td>
<td>Col. No. 2</td>
<td>Col. No. 3</td>
<td>Col. No. 4</td>
<td>Col. No. 5</td>
</tr>
<tr>
<td>1½ in.</td>
<td>1 in.</td>
<td>0 — 18</td>
<td>1½ in.</td>
<td>63</td>
</tr>
<tr>
<td>1 in.</td>
<td>¾ in.</td>
<td>11</td>
<td>1 in.</td>
<td>59</td>
</tr>
<tr>
<td>¾ in.</td>
<td>½ in.</td>
<td>12</td>
<td>½ in.</td>
<td>54</td>
</tr>
<tr>
<td>½ in.</td>
<td>¾ in.</td>
<td>9</td>
<td>¾ in.</td>
<td>51</td>
</tr>
<tr>
<td>#4</td>
<td>8</td>
<td>10 — 14</td>
<td>#8</td>
<td>32</td>
</tr>
<tr>
<td>#8</td>
<td>16</td>
<td>8 — 12</td>
<td>#16</td>
<td>24</td>
</tr>
<tr>
<td>#16</td>
<td>7 — 11</td>
<td>#30</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>#30</td>
<td>6 — 10</td>
<td>#50</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td>#50</td>
<td>5 — 9</td>
<td>#100</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>#100</td>
<td>4 — 8</td>
<td>#200</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Notes:
- COLUMN 5 is the same as Column 2 repeated for convenience and clarity
- COLUMN 6 is derived by adding the values in Column 3 from Fine to Coarse
- COLUMN 7 is derived by adding the values in Column 4 from Fine to Coarse
- COLUMN 8 is derived by adding the values in Column 3 from Coarse to Fine
- COLUMN 9 is derived by adding the values in Column 4 from Coarse to Fine
- COLUMN 10 is derived by subtracting the values in Column 8 from 100 (i.e. Column 10 = 100 — Column 8)
- COLUMN 11 is derived by subtracting the values in Column 9 from 100 (i.e. Column 11 = 100 — Column 9)
- The values for COLUMN 12 are obtained by selecting whichever value is the larger from either Column 6 or Column 11
- The values for COLUMN 13 are obtained by selecting whichever value is the smaller from either Column 7 or Column 10
- Notes: Where more or fewer screens sizes are used, Columns 3, 4 and 5 would be changed accordingly.
- Column values are used as specification limits in Columns 3 and 4 and in Columns 12 and 13. The figures used in this table were selected to indicate more clearly the method.
- It will be noted that a very narrow specification by the "Passing and Retained" method gives a much wider specification by the "Total Percent Passing" method. This ability of the "Total Percent Passing" method to provide a narrow control on the gradation, with reasonable margins on the screen sizes, is an important advantage of this method.
APPENDIX A

Evaluation of Materials

A.01 EXPLORATIONS AND BORINGS.—The materials investigation should include a sufficient number of borings to permit identification of the various soil types likely to be encountered both in the area of the proposed pavement and in the adjacent areas where material may be borrowed. A preliminary investigation which takes full advantage of any existing open ditches or cuts and the use of aerial photography will indicate the general areas of each soil type and make possible the strategic location of the boring sites so that the maximum information may be obtained from the least number of borings. The borings should be carried at least to the full depth of frost penetration or, where a cut is contemplated, to a depth of 6 feet below the grade line of the proposed subgrade. Borings in borrow areas should be carried well below the anticipated depth of borrow. The data obtained from these borings should be sufficient to develop soil profiles and to identify the principal soils in the area. Detailed tests should then be made of material obtained from large-size test pits or borings in areas representative of each soil type. The types of tests required are dependent upon the method of evaluation selected, as discussed in Chapter V and listed below.

A.02 EVALUATION METHODS.—Methods for evaluating materials as included in this manual and references to appropriate test procedures are as follows:


b. Unified Soil Classification—See Appendix B of Technical Memorandum 3-357, “The Unified Soil Classification System, Characteristics of Soil Groups Pertaining to Roads and Airfields,” published by the Waterways Experiment Station, Corps of Engineers, Department of the Army, Vicksburg, Mississippi.


APPENDIX B

Typical Examples

B.01 GENERAL.—A more thorough understanding of the design principles outlined in this chapter will be gained by a study of typical examples employing the procedures outlined in Part 3.

B.02 EXAMPLE 1.—Assume the following conditions:

Traffic Classification .................. Light
Maximum Single Axle Load ............ 10,000 lbs
Unified Soil Classification of Subgrade ... MH
Unified Soil Classification of Material Available for Base .......... GM-d

By reference to Figure V-3 it will be noted that soil types in the Unified Soil Classification system, as well as in the AASHO Classifications system, cover a range of bearing values and, therefore, indicate a range of thickness requirements. In such cases, it is usually necessary for the designer to examine the basic laboratory data, used in arriving at the specific classification, to determine the point within the range to be used in the design. Consideration should also be given to the expected climatic conditions in arriving at this design point. The general tendency should be toward the use of the lower side of the range in wet climates with freezing conditions and toward the higher side of the range for arid, non-freezing regions. In this particular example, it is assumed that the designer has decided to use the low side of the range for the MH type of subgrade, Unified Soil Classification system.

Referring to Figure V-3 and using procedures described in Part 3, it can be determined that the total required thickness of the asphalt pavement structure for the assumed traffic and load conditions is 6 inches. Table V-2 indicates that several types of asphalt pavement surface may normally be used for this type of traffic. For this particular example, however, it is assumed that the designer has decided to use a double surface treatment. Table V-3 indicates a 1-in. nominal thickness for a double surface treatment and suggests the use of Asphalt Institute Specification S-2, S-3, S-5 or a combination thereof. Since the required total thickness of pavement is 6 inches, then the required thickness of base is 5 inches.

Referring next to “a. Light Traffic” under Thickness and Quality Requirements for Non-Asphaltic Bases in this publication, it is noted that where surface treatments are used for “Light Traffic,” the base shall be of material classified as “Medium Base,” or better, according to the “General Soil Rating as Subgrade, Subbase or Base” (Figure V-3). It will be noted that the available base material assumed for this typical example meets this requirement.

The referenced portion of Chapter V, as noted above also requires a 5-in. minimum thickness of base and pavement. The 6-in. design thickness determined previously is thus in excess of the required minimum total thickness of base and pavement and, in fact, it would be theoretically possible to use a 1-inch sub-base in this design. The use of such a thin course, however, is impractical from the standpoint of practical construction and normally would be more costly than 1 inch of additional base material.

One design section for the conditions assumed in this typical example would be as follows:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; Double Surface Treatment</td>
<td></td>
</tr>
<tr>
<td>5&quot; Base—Unified Soil Classification of GM-d</td>
<td></td>
</tr>
<tr>
<td>Total 6&quot; Subgrade—Unified Soil Classification of MH</td>
<td></td>
</tr>
</tbody>
</table>

B.03 EXAMPLE 2.—Assume the following conditions:

Traffic Classification .................. Very Heavy
Maximum Single Axle Load ............ 36,000 lbs
Resistance (K) Value of Subgrade ...... 30
Resistance (R) Value of Improved Subgrade .... 46
Resistance (R) Value of Subbase ...... 71
Resistance (R) Value of Base .......... 82

By use of Figure V-3 it may be determined that the total thickness of the asphalt pavement structure required over a subgrade with an R value of 30, for an axle load of 36,000 lbs and for traffic classified as “Very Heavy” is 31 inches. Table V-3 recommends that asphalt concrete only be used as the pavement surface for “Very Heavy” traffic and Table V-3 suggests a 4-in. thickness of pavement surface for this type of traffic. Thus, a 4-in. thickness of asphalt concrete is tentatively selected for the pavement surface.

Figure V-3 indicates that the minimum thickness of base and pavement required over a subbase material with an R Value of 71 is 8 inches. Article 5:35, however, requires a minimum base and pavement thickness of 10 inches for “Very Heavy” traffic conditions. Therefore, 6 inches of base (R Value of 82) may be used in combination with the 4-in. asphalt-concrete surface selected as noted in the preceding paragraph.

Figure V-3 further indicates a minimum required thickness of 22 inches over the improved subgrade material with an R Value of 46. The upper 10 inches of the required 22-in. thickness must be base and pavement and the remaining 12 inches may be subbase.

It is noted above that the total required thickness of the asphalt pavement structure is 31 inches and that pavement, base and subbase total 22 inches. The remaining 9 inches may be made up of the improved subgrade material having an R Value of 46.
Thus, one design section for the conditions assumed in this example may be:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Description</th>
<th>R Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>Asphalt Concrete Pavement (Surface and Binder)</td>
<td></td>
</tr>
<tr>
<td>6”</td>
<td>Base – R Value = 82</td>
<td></td>
</tr>
<tr>
<td>12”</td>
<td>Subbase – R Value = 71</td>
<td></td>
</tr>
<tr>
<td>9”</td>
<td>Improved Subgrade – R Value = 46</td>
<td></td>
</tr>
<tr>
<td>Total 31”</td>
<td>Subgrade – R Value = 32</td>
<td></td>
</tr>
</tbody>
</table>

B.04 EXAMPLE 3.—Assume the same conditions as for the preceding Example 2 except that an asphalt base as described in Article 5.34, is to be considered. Article 5.36 observes that 1 in. of high-quality asphalt base may be substituted for 1½ in. of non-asphalt base. Thus, 4 in. of the asphalt base may be substituted for the 6-in. base noted in Example 2. This 2-in. reduction in base thickness may also be made in the required 31-in. total thickness of asphalt pavement structure, providing a design section as follows:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Description</th>
<th>R Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>Asphalt Concrete Pavement (Surface and Binder)</td>
<td></td>
</tr>
<tr>
<td>4”</td>
<td>Asphalt Base</td>
<td></td>
</tr>
<tr>
<td>12”</td>
<td>Subbase – R Value = 71</td>
<td></td>
</tr>
<tr>
<td>9”</td>
<td>Improved Subgrade – R Value = 46</td>
<td></td>
</tr>
<tr>
<td>Total 29”</td>
<td>Subgrade – R Value = 32</td>
<td></td>
</tr>
</tbody>
</table>

B.05 EXAMPLE 4.—A further modification of the design in Examples 2 and 3 may be made by the substitution of asphalt base for asphalt concrete binder course on an inch-for-inch basis.

For example, one might choose to use a 2½-inch asphalt concrete pavement, consisting of a 1½-inch binder course and a 1-inch surface course, and a 5½-inch asphalt base. The section design would then be:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Description</th>
<th>R Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2½”</td>
<td>Asphalt Concrete Pavement (Surface and Binder)</td>
<td></td>
</tr>
<tr>
<td>5½”</td>
<td>Asphalt Base</td>
<td></td>
</tr>
<tr>
<td>12”</td>
<td>Subbase – R Value = 71</td>
<td></td>
</tr>
<tr>
<td>9”</td>
<td>Improved Subgrade – R Value = 46</td>
<td></td>
</tr>
<tr>
<td>Total 29”</td>
<td>Subgrade – R Value = 32</td>
<td></td>
</tr>
</tbody>
</table>
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Colorado, Idaho, Illinois, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Utah, Wisconsin, Wyoming  

PIERRE, SOUTH DAKOTA—104 South Euclid  
North Dakota and South Dakota  

CHICAGO 39, ILLINOIS—6261 West Grand Avenue  
Wisconsin and Metropolitan Chicago  

SPRINGFIELD, ILLINOIS—2600 W. Springfield, Illinois (except Chicago), St. Louis County, Missouri  

KANSAS CITY 3, KANSAS—2500 Johnson Drive  
Kansas, Missouri (except St. Louis Co.), Nebraska  

DENVER 2, COLORADO—1031 15th Street  
Colorado, Utah, Wyoming  

HELENA, MONTANA—Power Block  
Idaho and Montana  

DIVISION IV—SOUTHWEST  

DALLAS 6, TEXAS—Meadows Building  
Arkansas, New Mexico, Oklahoma, Texas  

AUSTIN 1, TEXAS—Perry-Brooks Building  

TEXAS  

OKLAHOMA CITY 2, OKLAHOMA—Republic Building  
Arkansas, Oklahoma  

SANTA FE, NEW MEXICO—10 Radio Plaza  
New Mexico, Western Texas  

DIVISION V—PACIFIC COAST  

BERKELEY 10, CALIFORNIA—810 University Ave.  
Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington  

LOS ANGELES 17, CALIFORNIA—1709 West 8th St.  
Arizona, Southern California  

SACRAMENTO 14, CALIFORNIA—Forum Building  
Central California, Northern California, Nevada  

PORTLAND 1, OREGON—2035 S.W. 5th Avenue  
Oregon  

OLYMPIA, WASHINGTON—National Bank of Commerce Building  
Alaska, Washington