# Tables

## Contents


Table 1 - THE SEVEN SI BASE UNITS ..... 1
Table 2 - DERIVED SI UNITS APPROVED BY CGPM ..... 2
Table 3 - LIST OF COMMON DERIVED UNITS ..... 3
Table 4 - PREFIXES AND SYMBOLS TO INDICATE MAGNITUDE ..... 4
Table 5 (a) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE ..... 5
Table 5 (b) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE ..... 6
Table 5 (c) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE ..... 7
Table 5 (d) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE ..... 8
Table 5 (e) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE ..... 9
Table 5 (f) EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE ..... 10
Table 6 (a) - ISRM SYMBOLS RELATING TO SOIL AND ROCK MECHANICS ..... 11
Table 6 (b) - ISRM SYMBOLS RELATING TO SOIL AND ROCK MECHANICS ..... 12
Table 6 (c) - ISRM SYMBOLS RELATING TO SOIL AND ROCK MECHANICS ..... 13
Table 7 (a) - RANDOM NUMBERS ..... 14
Table 7 (b) - RANDOM NUMBERS ..... 15
Table 7 (c) - RANDOM NUMBERS ..... 16
Table 8 - AREAS UNDER THE STANDARD NORMAL CURVE FROM 0 to z. ..... 17
Table 9 - PERCENTILE VALUES (tp) FOR t-DISTRIBUTION ..... 18
Table 10 (a) - PERCENTAGE VALUES OF THE F-DISTRIBUTION ..... 19
Table 10 (b) - PERCENTAGE VALUES OF THE F-DISTRIBUTION ..... 20
Table 11 (a) - ERROR AND UNCERTAINTY ..... 21
Table 11 (b) - ERROR AND UNCERTAINTY ..... 22
Table 11 (c) - ERROR AND UNCERTAINTY ..... 23
Table 12 - PERCENTILE VALUES ($\chi P2$) FOR THE CHI-SQUARE DISTRIBUTION ..... 24
Table 13 - CRITICAL VALUES FOR $C_{0,01;\,n}$ ..... 25
Table 14 (a) - $F_A$-VALUES FOR SINGLE LIMIT SPECIFICATION. ..... 26
Table 14 (b) - $F_R$ VALUES FOR SINGLE LIMIT SPECIFICATION. ..... 27
Table 14 (c) - $F_A$-VALUES FOR DOUBLE LIMIT SPECIFICATION ..... 28
Table 14 (d) - $F_R$ VALUES FOR DOUBLE LIMIT SPECIFICATION ..... 29
Table 15 - CONTROL CHART CONSTANTS ..... 30

## **Table 1 -** THE SEVEN SI BASE UNITS

| Quantity[1] | Unit | Symbol |
|---|---|---|
| Length | metre | m |
| Mass | kilogram | kg |
| Time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Amount of substance | mole | mol |
| Luminous intensity | candela | cd |

DRAFT

[1] Quantity means measurable attribute of phenomena or matter.

## **Table 2 -** DERIVED SI UNITS APPROVED BY CGPM

| Quantity | Unit | Symbol | Formula |
|---|---|---|---|
| Frequency | hertz | Hz | 1/s |
| Force | newton | N | $kg.m/s^2$ |
| Pressure | pascal | Pa | $N/m^2$ |
| Stress | pascal | Pa | $N/m^2$ |
| Energy | joule | J | N.m |
| Work | joule | J | N.m |
| Quantity of heat | joule | J | N.m |
| Power | watt | W | J/s |
| Radiant flux | watt | W | J/s |
| Quantity of electricity | coulomb | C | A.s |
| Electric charge | coulomb | C | A.s |
| Electric potential | volt | V | W/A |
| Potential difference | volt | V | W/A |
| Electromotive force | volt | V | W/A |
| Electric capacitance | farad | F | C/V |
| Electric resistance | ohm | Ω | V/A |
| Electric conductance | siemens | S | A/V |
| Magnetic flux | weber | Wb | V.s |
| Magnetic flux density | tesla | T | $Wb/m^2$ |
| Inductance | henry | H | Wb/A |
| Temperature (Celsius) | degree | °C | K |
| Luminous flux | lumen | lm | cd.sr |

DRAFT

## **Table 3 -** LIST OF COMMON DERIVED UNITS

| Quantity | Unit | Symbol |
|---|---|---|
| Acceleration | metre per second squared | $m/s^2$ |
| Acceleration (angular) | radian per second squared | $rad/s^2$ |
| Velocity (angular) | radian per second | rad/s |
| Area | square metre | $m^2$ |
| Concentration | mole per cubic metre | $mol/m^3$ |
| Density | kilogram per cubic metre | $kg/m^3$ |
| Heat capacity | joule per kelvin | J/K |
| Heat flux density | warr per square metre | $W/m^2$ |
| Magnetic field strength | ampere per metre | A/m |
| Moment of force | newton metre | N·m |
| Power density | watt per square metre | $W/m^2$ |
| Radiance | watt per square metre steradian | $W/(m^2.sr)$ |
| Specific heat capacity | joule per kilogram kelvin | J/(kg·K) |
| Specific energy | joule per kilogram kelvin | J/kg |
| Surface tension | newton per metre | N/m |
| Thermal conductivity | watt per metre kelvin | W/(m.K) |
| Velocity | metre per second | m/s |
| Viscosity (dynamic) | pascal second | Pa·s |
| Viscosity (kinematic) | square metre per second | $m^2/s$ |
| Viscosity (Poiseuille) | kilogram per second per metre | $kg·s^{-1}\ m^{-1}$ |
| Volume | cubic metre | $m^3$ |

DRAFT

## **Table 4 -** PREFIXES AND SYMBOLS TO INDICATE MAGNITUDE

| Prefix | Symbol | Multiplication factor |
|---|---|---|
| yotta | Y | $1{,}0 \times 10^{24}$ |
| zetta | Z | $1{,}0 \times 10^{21}$ |
| exa | E | $1{,}0 \times 10^{18}$ |
| peta | P | $1{,}0 \times 10^{15}$ |
| tera | T | $1{,}0 \times 10^{12}$ |
| giga | G | $1{,}0 \times 10^{9}$ |
| mega | M | $1{,}0 \times 10^{6}$ |
| kilo | k | $1{,}0 \times 10^{3}$ |
| hecto* | h | $1{,}0 \times 10^{2}$ |
| deka* | da | $1{,}0 \times 10^{1}$ |
| deci* | d | $1{,}0 \times 10^{-1}$ |
| centi* | c | $1{,}0 \times 10^{-2}$ |
| milli | m | $1{,}0 \times 10^{-3}$ |
| micro | □ | $1{,}0 \times 10^{-6}$ |
| nano | n | $1{,}0 \times 10^{-9}$ |
| pico | p | $1{,}0 \times 10^{-12}$ |
| femto | f | $1{,}0 \times 10^{-15}$ |
| atto | a | $1{,}0 \times 10^{-18}$ |
| zepto | z | $1{,}0 \times 10^{-21}$ |
| yocto | y | $1{,}0 \times 10^{-24}$ |

* To be avoided where practical

DRAFT

## Table 5 (a) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE

**Acceleration**

| To convert from | to | Multiply by |
|---|---|---|
| ft/s$^2$ | metre per second squared (m/s$^2$) | 3,048 000*E-01 |
| Free fall, standard (g) | metre per second squared (m/s$^2$) | 9,806 650*E+00 |
| in/s$^2$ | metre per second squared (m/s$^2$) | 2,540 000*E-02 |

**Angle**

| To convert from | to | Multiply by |
|---|---|---|
| degree | radian (rad) | 1,745 329 E-02 |
| minute | radian (rad) | 2,908 882 E-04 |
| second | radian (rad) | 4,848 137 E-06 |

**Area**

| To convert from | to | Multiply by |
|---|---|---|
| acre | square metre (m$^2$) | 4,046 873 E+03 |
| ft$^2$ | square metre (m$^2$) | 9,290 304*E-02 |
| hectare | square metre (m$^2$) | 1,000 000*E+04 |
| in$^2$ | square metre (m$^2$) | 6,451 600*E-04 |
| mi$^2$ (international) | square metre (m$^2$) | 2,589 988 E+06 |

**Torque (bending moment)**

| To convert from | to | Multiply by |
|---|---|---|
| dyne·cm | newton metre (N·m) | 1,000 000*E-07 |
| kgf·m | newton metre (N·m) | 9,806 650*E+00 |
| lbf·in | newton metre (N·m) | 1,129 848 E-01 |
| lbf·ft | newton metre (N·m) | 1,355 818 E+00 |

**Electricity and magnetism**

| To convert from | to | Multiply by |
|---|---|---|
| ampere hour | coulomb (C) | 3,600 000*E+09 |
| faraday (physical) | coulomb (C) | 9,652 19 E+04 |
| gauss | tesla (T) | 1,000 000*E-04 |
| gilbert | ampere (A) | 7,957 747 E-01 |
| maxwell | weber (Wb) | 1,000 000*E-08 |
| mho | siemens (S) | 1,000 000*E+00 |
| oersted | ampere per metre (A/m) | 7,957 747 E+01 |

DRAFT

## Table 5 (b) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE

**Energy**

| To convert from | to | Multiply by |
|---|---|---|
| British thermal unit (international) | joule (J) | 1,055 056 E+03 |
| calorie (international) | joule (J) | 4,186 800*E+00 |
| electronvolt | joule (J) | 1,602 19 E-19 |
| erg | joule (J) | 1,000 000*E-07 |
| ft·lbf | joule (J) | 1,355 818 E+00 |
| kW·h | joule (J) | 3,600 000*E+06 |
| ton (nuclear equivalent of TNT) | joule (J) | 4,184 E+09 |

**Energy per unit area time**

| To convert from | to | Multiply by |
|---|---|---|
| Btu (international)/($ft^2$·s) | watt per metre ($W/m^2$) | 1,135 653 E+04 |
| cal (thermochemical)/($cm^2$·s) | watt per metre ($W/m^2$) | 4,184 000*E+04 |
| erg/($cm^2$·s) | watt per metre ($W/m^2$) | 1,000 000*E-03 |
| $W/cm^2$ | watt per metre ($W/m^2$) | 1,000 000*E+04 |
| $W/in^2$ | watt per metre ($W/m^2$) | 1,550 003 E+03 |

**Force**

| To convert from | to | Multiply by |
|---|---|---|
| dyne | newton (N) | 1,000 000*E-05 |
| kilogram-force | newton (N) | 9,806 650*E+00 |
| kip (1000 ibf) | newton (N) | 4,448 222 E+03 |
| pound-force (lbf) | newton (N) | 4,448 222 E+00 |
| poundal | newton (N) | 1,382 550 E-01 |
| ton-force | newton (N) | 8,896 443 E+03 |

**Heat**

| To convert from | to | Multiply by |
|---|---|---|
| Btu (international)·ft/(h·$ft^2$·°F) *thermal conductivity* | watt per metre kelvin [W/(m·K)] | 1,730 735 E+00 |
| Btu (international)·in/(h·$ft^2$·°F) *thermal conductivity* | watt per metre kelvin [W/(m·K)] | 1,442 279 E-01 |
| Btu (international)/$ft^2$ | joule per square metre ($J/m^2$) | 1,135 653 E+04 |
| Btu (international)/(h·$ft^2$·°F) *thermal conductance* | watt per square metre kelvin [W/($m^2$·K)] | 5,678 263 E+00 |
| cal (thermochemical)/$cm^2$ | joule per square metre ($J/m^2$) | 4,184 000*E+04 |
| cal (thermochemical)/($cm^2$·min) | watt per square metre ($W/m^2$) | 6,973 333 E+02 |
| cal (international)/g | joule per kilogram (J/kg) | 4,186 800*E+03 |
| cal (international)/(g·°C) | joule per kilogram kelvin [J/(kg·K)] | 4,186 800*E+03 |

DRAFT

## Table 5 (c) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE

**Length**

| To convert from | to | Multiply by |
|---|---|---|
| angstrom | metre (m) | 1,000 000*E-10 |
| astronomical unit | metre (m) | 1,495 979 E+11 |
| chain (66 ft) | metre (m) | 2,011 684 E+01 |
| fathom (6 ft) | metre (m) | 1,828 804 E+00 |
| foot (international) | metre (m) | 3,048 000*E-01 |
| foot (Cape) | metre (m) | 3,314 858 E-01 |
| inch | metre (m) | 2,540 000*E-02 |
| light year | metre (m) | 9,460 55 E+15 |
| micron | metre (m) | 1,000 000*E-06 |
| mil | metre (m) | 2,540 000*E-05 |
| mile (international - nautical) | metre (m) | 1,852 000*E+03 |
| mile (international) | metre (m) | 1,609 344*E+03 |
| parsec | metre (m) | 3,085 678 E+16 |
| rod (16.5 ft) | metre (m) | 5,029 210 E+00 |
| yard | metre (m) | 9,144 000*E-01 |

**Light**

| To convert from | to | Multiply by |
|---|---|---|
| cd/in$^2$ | candela per square metre (cd/m$^2$) | 1,550 003 E+03 |
| footcandle | lux (lx) | 1,076 391 E+01 |
| lambert | candela per square metre (cd/m$^2$) | 3,183 099 E+03 |
| lm/ft$^2$ | lumen per square metre (lm/m$^2$) | 1,076 391 E+01 |

**Mass**

| To convert from | to | Multiply by |
|---|---|---|
| carat (metric) | kilogram (kg) | 2,000 000*E-04 |
| grain | kilogram (kg) | 6,479 891*E-05 |
| gram | kilogram (kg) | 1,000 000*E-03 |
| ounce (oz, avoirdupois) | kilogram (kg) | 2,834 952 E-02 |
| ounce (troy) | kilogram (kg) | 3,110 348 E-02 |
| pound (lb, avoirdupois) | kilogram (kg) | 4,535 924 E-01 |
| ton (long, 2240 ib) | kilogram (kg) | 1,016 047 E+03 |
| ton (short, 2000 lb) | kilogram (kg) | 9,071 847 E+02 |

**Mass per unit area**

| To convert from | to | Multiply by |
|---|---|---|
| lb/ft$^2$ | kilogram per square metre (kg/m$^2$) | 4,882 428 E+00 |

DRAFT

## Table 5 (d) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE

**Mass per unit length**

| To convert from | to | Multiply by |
|---|---|---|
| lb/ft | kilogram per metre (kg/m) | 1,488 164 E+00 |
| lb/in | kilogram per metre (kg/m) | 1,785 797 E+01 |

**Mass per unit volume**

| To convert from | to | Multiply by |
|---|---|---|
| $g/cm^3$ | kilogram per cubic metre ($kg/m^3$) | 1,000 000*E+03 |
| $lb/ft^3$ | kilogram per cubic metre ($kg/m^3$) | 1,601 846 E+01 |
| $lb/in^3$ | kilogram per cubic metre ($kg/m^3$) | 2,767 990 E+04 |
| ton (long)/$yd^3$ | kilogram per cubic metre ($kg/m^3$) | 1,328 939 E+03 |
| ton (short)/$yd^3$ | kilogram per cubic metre ($kg/m^3$) | 1,186 553 E+03 |

**Power**

| To convert from | to | Multiply by |
|---|---|---|
| Btu (international) | watt (W) | 2,930 711 E-01 |
| erg/s | watt (W) | 1,000 000*E-07 |
| ft·lbf/s | watt (W) | 1,355 818 E+00 |
| horsepower (550 ft·lbf/s) | watt (W) | 7,456 999 E+02 |
| horsepower (electric) | watt (W) | 7,460 000*E+02 |

**Pressure or stress**

| To convert from | to | Multiply by |
|---|---|---|
| atmosphere (standard) | pascal (Pa) | 1,013 250*E+05 |
| bar | pascal (Pa) | 1,000 000*E+05 |
| centimetre of mercury (0°C) | pascal (Pa) | 1,333 22 E+03 |
| centimetre of water (4°C) | pascal (Pa) | 9,806 38 E+01 |
| $dyne/cm^2$ | pascal (Pa) | 1,000 000*E-01 |
| $gf/cm^2$ | pascal (Pa) | 9,806 650*E+01 |
| inch of mercury (32°F) | pascal (Pa) | 3,386 38 E+03 |
| inch of mercury (60°F) | pascal (Pa) | 3,376 85 E+03 |
| $kgf/cm^2$ | pascal (Pa) | 9,806 650*E+04 |
| $kgf/m^2$ | pascal (Pa) | 9,806 650*E+00 |
| millibar | pascal (Pa) | 1,000 000*E+02 |
| $lbf/ft^2$ | pascal (Pa) | 4,788 026 E+01 |
| $lbf/in^2$ | pascal (Pa) | 6,894 757 E+03 |
| psi | pascal (Pa) | 6,894 757 E+03 |

DRAFT

## Table 5 (e) - EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE

**Radiation units**

| To convert from | to | Multiply by |
|---|---|---|
| curie | becquerel (Bq) | 3,700 000*E+10 |
| roentgen | coulomb per kilogram (C/kg) | 2,580 000*E-04 |

**Temperature**

| To convert from | to | Multiply by |
|---|---|---|
| degree Celsius | kelvin (K) | $T_K = t_{°C} + 273,15$ |
| degree Fahrenheit | degree Celsius (°C) | $t_{°C} = (t_{°F} - 32)/1,8$ |
| degree Fahrenheit | kelvin (K) | $T_K = (t_{°F} + 459,67)/1,8$ |
| kelvin | degree Celsius (°C) | $t_{°C} = T_K - 273,15$ |

**Time**

| To convert from | to | Multiply by |
|---|---|---|
| day | second (s) | 8,640 000*E+04 |
| day (sidereal) | second (s) | 8,616 409 E+04 |
| hour | second (s) | 3,600 000*E+03 |
| minute | second (s) | 6,000 000*E+01 |
| year (365 days) | second (s) | 3,153 600*E+07 |

**Velocity**

| To convert from | to | Multiply by |
|---|---|---|
| ft/h | metre per second (m/s) | 8,466 667 E-05 |
| ft/min | metre per second (m/s) | 5,080 000*E-03 |
| ft/s | metre per second (m/s) | 3,048 000*E-01 |
| km/h | metre per second (m/s) | 2,777 778 E-01 |
| knot (international) | metre per second (m/s) | 5,144 444 E-01 |
| mi/h (international) | metre per second (m/s) | 4,470 400*E-01 |
| rpm (r/min) | radian per second (rad/s) | 1,047 198 E-01 |

**Viscosity**

| To convert from | to | Multiply by |
|---|---|---|
| centipoise (dynamic) | pascal second (Pa·s) | 1,000 000*E-03 |
| centistokes (kinematic) | square metre per second ($m^2/s$) | 1,000 000*E-06 |
| $ft^2/s$ | square metre per second ($m^2/s$) | 9,290 304*E-02 |
| poise | pascal second (Pa·s) | 1,000 000*E-01 |
| stokes | square metre per second ($m^2/s$) | 1,000 000*E-04 |

DRAFT

## Table 5 (f) EQUIVALENT VALUES FOR MISCELLANEOUS UNITS OF MEASURE

**Volume**

| To convert from | to | Multiply by |
|---|---|---|
| barrel (oil, 42 gal) | cubic metre ($m^3$) | 1,589 873 E-01 |
| $ft^3$ | cubic metre ($m^3$) | 2,831 685 E-02 |
| gallon (U.K.) | cubic metre ($m^3$) | 4,546 092 E-03 |
| $in^3$ | cubic metre ($m^3$) | 1,638 706 E-05 |
| litre | cubic metre ($m^3$) | 1,000 000*E-03 |
| ounce (U.K. fluid) | cubic metre ($m^3$) | 2,841 306 E-05 |
| pint (U.K. fluid) | cubic metre ($m^3$) | 5,682 45 E-02 |
| $yd^3$ | cubic metre ($m^3$) | 7,645 549 E-01 |

**Volume per unit time**

| To convert from | to | Multiply by |
|---|---|---|
| $ft^3$/min | cubic metre per second ($m^3$/s) | 4,719 474 E-04 |
| $ft^3$/s | cubic metre per second ($m^3$/s) | 2,831 685 E-02 |
| $in^3$/min | cubic metre per second ($m^3$/s) | 2,731 177 E-07 |

DRAFT

## Table 6 (a) - ISRM[2] SYMBOLS RELATING TO SOIL AND ROCK MECHANICS

| Symbol | Definition | Symbol | Definition |
|---|---|---|---|
| **Space** | | $G_m$ | mass specific gravity |
| Ω, ω | solid angle | $G_s$ | specific gravity of solids |
| $l$ | length | $G_w$ | specific gravity of water |
| $b$ | width | F | force |
| $h$ | height | T | tangential force |
| $h$ | depth | $W$ | weight |
| r | radius | $\gamma$ | unit weight |
| $A$ | area | $\gamma_d$ | dry unit weight |
| $V$ | volume | $\gamma_w$ | unit weight of water |
| $t$ | time | $\gamma'$ | buoyant unit weight |
| $v$ | velocity | $\gamma_s$ | unit of solids |
| ω | angular velocity | T | torque |
| g | gravitational acceleration | I | moment of inertia |
| **Periodic** | | $W$ | work |
| $T$ | periodic time | $W$ | energy |
| $f$ | frequency | **Mechanics** | |
| ω | angular velocity | $e$ | void ratio |
| λ | wave length | $n$ | porosity |
| **Statics and dynamics** | | w | water content |
| m | mass | $S_r$ | degree of saturation |
| ρ | density (mass density) | $p$ | pressure |
| | | $u$ | pore water pressure |
| | | σ | normal stress |
| | | $\sigma_x$, $\sigma_y$, $\sigma_z$ | stress components in rectangular coordinates |

[2] ISRM: International Society for Rock Mechanics

## Table 6 (b) - ISRM SYMBOLS RELATING TO SOIL AND ROCK MECHANICS

| Symbol | Definition | Symbol | Definition |
|---|---|---|---|
| $\sigma_1$, $\sigma_2$, $\sigma_3$ | principal stresses | $t_{rel}$ | relaxation time |
| $S_1$, $S_2$, $S_3$ | applied stresses (and reactions) | $T_s$ | surface tension |
| $\sigma_h$ | horizontal stress | $q$ | quantity rate of flow; rate of discharge |
| $\sigma_v$ | vertical stress | $Q$ | quantity of flow |
| $\tau$ | shear stress | $FS$ | safety factor |
| $\tau_{xy}$, $\tau_{yz}$, $\tau_{zx}$ | shear stress components in rectangular coordinates | **Heat** | |
| $\varepsilon$ | strain | T | temperature |
| $\varepsilon_x$, $\varepsilon_y$, $\varepsilon_z$ | strain components in rectangular coordinates | $\beta$ | coefficient of volume expansion |
| $\gamma_{xy}$, $\gamma_{yz}$ , $\gamma_{zx}$ | shear strain components in rectangular coordinates | **Electricity** | |
| $\theta$ | volume strain | I | electric current |
| $E$ | Young's modulus; modulus of elasticity | Q | electric charge |
| $\varepsilon_1$, $\varepsilon_2$, $\varepsilon_3$ | principal strains | C | capacitance |
| $G$ | shear modulus; modulus of rigidity | L | self-induction |
| $c$ | cohesion | R | resistance |
| $\phi_s$ | angle of friction between solid bodies | $\rho$ | resistivity |
| $\phi$ | angle of shear resistance (angle of internal friction) | A - Z | Measurements, readings, etc. Avoid the letters {I,O} |
| $h$ | hydraulic head | $D$ | Maximum pore diameter |
| $i$ | hydraulic gradient | $\Delta T$ | Difference in temperature |

DRAFT

## Table 6 (c) - ISRM SYMBOLS RELATING TO SOIL AND ROCK MECHANICS

| Symbol | Definition | Symbol | Definition |
|---|---|---|---|
| $j$ | seepage force per unit volume or seepage pressure per unit length | $R$ | Modulus of rapture |
| $k$ | coefficient of permeability | $W$ | Breaking load |
| $\eta$ | viscosity | $t$ | Thickness |
| $\eta_{pl}$ | plasticity (viscosity of Bingham body) | $M_i$ | Mass of sample at condition *i* |
| $t_{ret}$ | retardation time | M | Mass of wet sample |
| $M_0$ | Mass of dry sample | $L_s$ | Linear Shrinkage |
| $C$ | Compressive strength | $\rho_w$ | Density of water |
| $G_t$ | Specific gravity of type *t* | $\gamma_d$ | Dry unit mass of compacted sample |
| $H_m$ | Resistance (wear) of type *m* | $\gamma_m$ | Wet unit mass of compacted sample |
| $\sigma$ | Flexural strength | $\gamma_w$ | Unit mass of water |
| $V_w$ | Volume of wet sample | $\gamma_{max}$ | Maximum dry unit mass of compacted sample |
| $V_d$ | Volume of dry sample | P | Percentage |

DRAFT

## Table 7 (a) - RANDOM NUMBERS

| $R_X$ | $R_Y$ | $R_X$ | $R_Y$ | $R_X$ | $R_Y$ | $R_X$ | $R_Y$ |
|---|---|---|---|---|---|---|---|
| 0,4556 | 0,8303 | 0,7061 | 0,7257 | 0,2877 | 0,5528 | 0,9627 | 0,4434 |
| 0,3926 | 0,3023 | 0,0074 | 0,9700 | 0,2077 | 0,5408 | 0,6333 | 0,8912 |
| 0,5805 | 0,4138 | 0,8389 | 0,4035 | 0,8455 | 0,6448 | 0,7733 | 0,6033 |
| 0,5835 | 0,3826 | 0,8163 | 0,3708 | 0,5930 | 0,4115 | 0,5748 | 0,5071 |
| 0,1066 | 0,6280 | 0,0762 | 0,2781 | 0,7822 | 0,1923 | 0,9405 | 0,0238 |
| 0,5006 | 0,2589 | 0,8118 | 0,9879 | 0,5018 | 0,6943 | 0,8313 | 0,0245 |
| 0,8898 | 0,6869 | 0,4323 | 0,3381 | 0,0381 | 0,6559 | 0,2388 | 0,9129 |
| 0,9266 | 0,3650 | 0,3488 | 0,7874 | 0,9418 | 0,6477 | 0,7835 | 0,8319 |
| 0,1704 | 0,6503 | 0,3841 | 0,1836 | 0,7193 | 0,9982 | 0,9368 | 0,9960 |
| 0,0913 | 0,7928 | 0,8078 | 0,6594 | 0,1491 | 0,8446 | 0,8691 | 0,1480 |
| 0,6989 | 0,0485 | 0,9966 | 0,6509 | 0,2232 | 0,3086 | 0,9222 | 0,1413 |
| 0,7966 | 0,9176 | 0,7195 | 0,0428 | 0,7134 | 0,7974 | 0,7071 | 0,6467 |
| 0,8601 | 0,5078 | 0,0477 | 0,4376 | 0,3629 | 0,4287 | 0,8268 | 0,9844 |
| 0,5418 | 0,0226 | 0,8902 | 0,5503 | 0,7027 | 0,5827 | 0,2235 | 0,0815 |
| 0,7990 | 0,3748 | 0,1532 | 0,7278 | 0,4928 | 0,5769 | 0,1517 | 0,5535 |
| 0,6485 | 0,9244 | 0,5263 | 0,5935 | 0,7888 | 0,4670 | 0,7756 | 0,9115 |
| 0,5451 | 0,3422 | 0,8918 | 0,8167 | 0,6332 | 0,9734 | 0,3920 | 0,8944 |
| 0,3856 | 0,5979 | 0,3599 | 0,0075 | 0,3718 | 0,5310 | 0,2776 | 0,9257 |
| 0,1377 | 0,0732 | 0,9298 | 0,7360 | 0,5953 | 0,4657 | 0,1620 | 0,6955 |
| 0,0941 | 0,8008 | 0,7734 | 0,6768 | 0,7055 | 0,2947 | 0,3252 | 0,8680 |
| 0,7510 | 0,8268 | 0,1467 | 0,8788 | 0,1065 | 0,1529 | 0,3201 | 0,9128 |
| 0,3124 | 0,6995 | 0,9244 | 0,1593 | 0,0219 | 0,3429 | 0,3207 | 0,0626 |
| 0,8188 | 0,0825 | 0,7600 | 0,6242 | 0,9352 | 0,0114 | 0,0940 | 0,3948 |
| 0,9012 | 0,4932 | 0,8711 | 0,3118 | 0,6569 | 0,9497 | 0,5982 | 0,0387 |
| 0,1597 | 0,1658 | 0,4497 | 0,9629 | 0,0157 | 0,5193 | 0,2052 | 0,5076 |
| 0,1682 | 0,0396 | 0,6971 | 0,9150 | 0,1747 | 0,7034 | 0,5484 | 0,1556 |
| 0,1022 | 0,8727 | 0,4840 | 0,1219 | 0,5733 | 0,2818 | 0,9948 | 0,7599 |
| 0,9937 | 0,4795 | 0,6362 | 0,2983 | 0,4931 | 0,1322 | 0,7434 | 0,2277 |
| 0,6094 | 0,0949 | 0,8439 | 0,1894 | 0,2495 | 0,6559 | 0,5476 | 0,4281 |
| 0,9551 | 0,8618 | 0,1977 | 0,9652 | 0,0082 | 0,3284 | 0,0623 | 0,1494 |
| 0,4043 | 0,4448 | 0,3482 | 0,7401 | 0,2266 | 0,3756 | 0,8177 | 0,1809 |
| 0,4521 | 0,7686 | 0,2914 | 0,2177 | 0,7200 | 0,5741 | 0,8158 | 0,5202 |
| 0,0944 | 0,8808 | 0,7787 | 0,4600 | 0,3531 | 0,1770 | 0,7536 | 0,7048 |
| 0,8316 | 0,9405 | 0,3523 | 0,7819 | 0,3566 | 0,9654 | 0,8708 | 0,2696 |
| 0,2974 | 0,3316 | 0,0051 | 0,7712 | 0,2684 | 0,4230 | 0,4224 | 0,3288 |
| 0,5129 | 0,9009 | 0,4660 | 0,4326 | 0,5000 | 0,0381 | 0,7764 | 0,2825 |
| 0,7654 | 0,3217 | 0,1099 | 0,4575 | 0,5280 | 0,7286 | 0,1360 | 0,6495 |
| 0,1124 | 0,5817 | 0,4932 | 0,6184 | 0,7104 | 0,3927 | 0,8879 | 0,0235 |
| 0,5105 | 0,5965 | 0,5136 | 0,2886 | 0,7283 | 0,5855 | 0,5748 | 0,1560 |
| 0,5690 | 0,9479 | 0,1953 | 0,0867 | 0,6518 | 0,3187 | 0,4927 | 0,1625 |

DRAFT

## **Table 7 (b) -** RANDOM NUMBERS

| $R_X$ | $R_Y$ | $R_X$ | $R_Y$ | $R_X$ | $R_Y$ | $R_X$ | $R_Y$ |
|---|---|---|---|---|---|---|---|
| 0,3820 | 0,1007 | 0,5965 | 0,8991 | 0,8846 | 0,9585 | 0,0145 | 0,4074 |
| 0,8632 | 0,1386 | 0,2450 | 0,0455 | 0,0324 | 0,1641 | 0,2196 | 0,0171 |
| 0,2850 | 0,3431 | 0,5536 | 0,3574 | 0,3718 | 0,3556 | 0,9103 | 0,4660 |
| 0,4262 | 0,3039 | 0,9757 | 0,8067 | 0,9912 | 0,2563 | 0,9517 | 0,0534 |
| 0,7050 | 0,8165 | 0,9725 | 0,4663 | 0,3002 | 0,7502 | 0,3515 | 0,7757 |
| 0,0743 | 0,1984 | 0,0641 | 0,3583 | 0,4870 | 0,5112 | 0,3735 | 0,9859 |
| 0,0407 | 0,2307 | 0,0050 | 0,9261 | 0,1003 | 0,2567 | 0,7757 | 0,6796 |
| 0,8091 | 0,7243 | 0,0851 | 0,1323 | 0,7562 | 0,6265 | 0,1737 | 0,4048 |
| 0,5523 | 0,7115 | 0,5552 | 0,1812 | 0,9703 | 0,6869 | 0,5288 | 0,7967 |
| 0,8057 | 0,2622 | 0,1780 | 0,8668 | 0,1148 | 0,0595 | 0,7616 | 0,7384 |
| 0,9863 | 0,9256 | 0,9039 | 0,5450 | 0,5008 | 0,6750 | 0,4898 | 0,1458 |
| 0,0380 | 0,7963 | 0,6716 | 0,7317 | 0,5845 | 0,1522 | 0,8922 | 0,3778 |
| 0,2005 | 0,2058 | 0,3340 | 0,3251 | 0,3002 | 0,8022 | 0,6961 | 0,2715 |
| 0,9040 | 0,0391 | 0,7090 | 0,4537 | 0,5166 | 0,2565 | 0,2913 | 0,8021 |
| 0,7890 | 0,6760 | 0,7553 | 0,9485 | 0,6194 | 0,7221 | 0,9680 | 0,3686 |
| 0,8504 | 0,5571 | 0,8731 | 0,4411 | 0,2177 | 0,8590 | 0,2803 | 0,7033 |
| 0,7074 | 0,3758 | 0,3297 | 0,0860 | 0,9769 | 0,2855 | 0,5343 | 0,4074 |
| 0,9977 | 0,8947 | 0,8108 | 0,9086 | 0,5745 | 0,7061 | 0,4014 | 0,1110 |
| 0,8974 | 0,3863 | 0,0958 | 0,7776 | 0,7836 | 0,6657 | 0,6568 | 0,2585 |
| 0,7652 | 0,7003 | 0,8588 | 0,0028 | 0,6786 | 0,9288 | 0,0425 | 0,5181 |
| 0,9121 | 0,9543 | 0,5943 | 0,5577 | 0,9682 | 0,4830 | 0,2556 | 0,8179 |
| 0,4960 | 0,8506 | 0,6681 | 0,9269 | 0,4518 | 0,1681 | 0,0620 | 0,0052 |
| 0,5411 | 0,6176 | 0,4929 | 0,5795 | 0,6019 | 0,9301 | 0,5340 | 0,1321 |
| 0,0823 | 0,5759 | 0,8292 | 0,0657 | 0,2709 | 0,6997 | 0,4142 | 0,3656 |
| 0,4351 | 0,3301 | 0,2111 | 0,7405 | 0,5235 | 0,8968 | 0,6034 | 0,5228 |
| 0,5898 | 0,5849 | 0,4970 | 0,1105 | 0,5930 | 0,5589 | 0,7741 | 0,2308 |
| 0,7312 | 0,5867 | 0,5455 | 0,8073 | 0,9643 | 0,0954 | 0,1086 | 0,7123 |
| 0,8831 | 0,1899 | 0,0160 | 0,1845 | 0,5800 | 0,6661 | 0,1623 | 0,1951 |
| 0,6778 | 0,5484 | 0,2946 | 0,5408 | 0,1732 | 0,1853 | 0,8524 | 0,9481 |
| 0,2508 | 0,4317 | 0,5449 | 0,9675 | 0,7241 | 0,9510 | 0,5703 | 0,9406 |
| 0,2599 | 0,1670 | 0,8838 | 0,8209 | 0,0419 | 0,8983 | 0,4208 | 0,1282 |
| 0,0301 | 0,2047 | 0,6820 | 0,8206 | 0,4723 | 0,4785 | 0,5850 | 0,3624 |
| 0,8233 | 0,3106 | 0,9904 | 0,7716 | 0,7293 | 0,1633 | 0,8083 | 0,9261 |
| 0,2323 | 0,3817 | 0,0902 | 0,9120 | 0,8520 | 0,5731 | 0,0142 | 0,6934 |
| 0,7006 | 0,8880 | 0,1690 | 0,8860 | 0,2871 | 0,2316 | 0,0423 | 0,9154 |
| 0,1672 | 0,9389 | 0,1216 | 0,3413 | 0,0955 | 0,9441 | 0,5115 | 0,6295 |
| 0,8356 | 0,9744 | 0,4757 | 0,1516 | 0,2846 | 0,8017 | 0,8085 | 0,6952 |
| 0,0686 | 0,0813 | 0,4428 | 0,2647 | 0,2651 | 0,8103 | 0,2009 | 0,4543 |
| 0,4082 | 0,9355 | 0,0938 | 0,1748 | 0,4335 | 0,1443 | 0,0758 | 0,0153 |

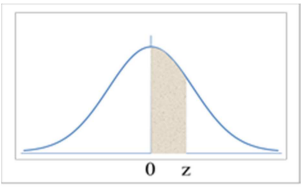
DRAFT

## **Table 7 (c) -** RANDOM NUMBERS

| $R_X$ | $R_Y$ | $R_X$ | $R_Y$ | $R_X$ | $R_Y$ | $R_X$ | $R_Y$ |
|---|---|---|---|---|---|---|---|
| 0,4600 | 0,5536 | 0,9587 | 0,3062 | 0,2134 | 0,2276 | 0,7213 | 0,9004 |
| 0,0756 | 0,8338 | 0,9438 | 0,2524 | 0,5331 | 0,2037 | 0,7566 | 0,5945 |
| 0,5186 | 0,1516 | 0,3822 | 0,7656 | 0,4961 | 0,8419 | 0,1553 | 0,7760 |
| 0,8928 | 0,1211 | 0,6541 | 0,0374 | 0,5316 | 0,8429 | 0,8498 | 0,5419 |
| 0,2231 | 0,7185 | 0,6788 | 0,7669 | 0,1713 | 0,7246 | 0,9464 | 0,5926 |
| 0,3500 | 0,5982 | 0,9655 | 0,0082 | 0,5067 | 0,4510 | 0,8388 | 0,8918 |
| 0,9490 | 0,0345 | 0,7893 | 0,6431 | 0,7710 | 0,6858 | 0,4462 | 0,9515 |
| 0,6752 | 0,4876 | 0,4918 | 0,4791 | 0,0462 | 0,6712 | 0,5764 | 0,7424 |
| 0,4329 | 0,7955 | 0,9068 | 0,9714 | 0,0950 | 0,7324 | 0,4146 | 0,2290 |
| 0,7701 | 0,9901 | 0,9114 | 0,5713 | 0,3180 | 0,4059 | 0,1361 | 0,5298 |
| 0,3980 | 0,7387 | 0,1013 | 0,6982 | 0,8356 | 0,1938 | 0,6449 | 0,7023 |
| 0,8354 | 0,4103 | 0,5922 | 0,3376 | 0,6950 | 0,9426 | 0,4368 | 0,1530 |
| 0,1784 | 0,7672 | 0,9448 | 0,2637 | 0,2026 | 0,8468 | 0,5882 | 0,6733 |
| 0,9953 | 0,2812 | 0,2163 | 0,8873 | 0,3804 | 0,0783 | 0,8685 | 0,0988 |
| 0,3452 | 0,0751 | 0,1360 | 0,7278 | 0,5484 | 0,0401 | 0,9792 | 0,5950 |
| 0,9232 | 0,4892 | 0,4057 | 0,5116 | 0,0320 | 0,2451 | 0,9166 | 0,5670 |
| 0,3301 | 0,2726 | 0,1259 | 0,8941 | 0,9933 | 0,8201 | 0,4605 | 0,1952 |
| 0,4662 | 0,3995 | 0,3464 | 0,8080 | 0,3883 | 0,6346 | 0,7873 | 0,5951 |
| 0,0516 | 0,5108 | 0,7422 | 0,4355 | 0,0495 | 0,0551 | 0,2082 | 0,6025 |
| 0,2702 | 0,9804 | 0,4141 | 0,8061 | 0,8924 | 0,3233 | 0,0325 | 0,1837 |
| 0,5394 | 0,6068 | 0,8147 | 0,0190 | 0,2475 | 0,5607 | 0,5563 | 0,4707 |
| 0,4049 | 0,9292 | 0,7990 | 0,0915 | 0,3177 | 0,3973 | 0,1749 | 0,4212 |
| 0,5596 | 0,1689 | 0,8001 | 0,4309 | 0,7600 | 0,2251 | 0,6222 | 0,1039 |
| 0,9888 | 0,7962 | 0,1304 | 0,9322 | 0,3926 | 0,0776 | 0,3328 | 0,6089 |
| 0,2394 | 0,7212 | 0,4070 | 0,7013 | 0,0272 | 0,1334 | 0,9314 | 0,5820 |
| 0,8144 | 0,1107 | 0,1025 | 0,4021 | 0,4256 | 0,8451 | 0,8451 | 0,3859 |
| 0,6925 | 0,8291 | 0,2210 | 0,2297 | 0,3822 | 0,6931 | 0,0426 | 0,8848 |
| 0,9728 | 0,5052 | 0,0986 | 0,5073 | 0,9304 | 0,5651 | 0,8967 | 0,8545 |
| 0,6440 | 0,2236 | 0,3296 | 0,9098 | 0,6753 | 0,7590 | 0,1729 | 0,0178 |
| 0,4791 | 0,8408 | 0,8168 | 0,3103 | 0,2504 | 0,6129 | 0,1428 | 0,7045 |
| 0,0551 | 0,9271 | 0,9475 | 0,2542 | 0,8997 | 0,7582 | 0,8223 | 0,1367 |
| 0,8972 | 0,3323 | 0,8943 | 0,0553 | 0,1846 | 0,9987 | 0,3347 | 0,3388 |
| 0,7486 | 0,3778 | 0,0410 | 0,5198 | 0,8161 | 0,8148 | 0,3993 | 0,6728 |
| 0,9648 | 0,6726 | 0,5330 | 0,2930 | 0,6117 | 0,4922 | 0,9443 | 0,9982 |
| 0,0334 | 0,5549 | 0,9536 | 0,8326 | 0,5776 | 0,8756 | 0,8453 | 0,4575 |
| 0,2184 | 0,1585 | 0,1241 | 0,0059 | 0,1155 | 0,7479 | 0,7889 | 0,8862 |
| 0,3299 | 0,1039 | 0,0305 | 0,3128 | 0,3550 | 0,8343 | 0,2602 | 0,8479 |
| 0,6184 | 0,8151 | 0,8734 | 0,7332 | 0,6102 | 0,4303 | 0,6569 | 0,2945 |
| 0,7947 | 0,4610 | 0,2443 | 0,1997 | 0,9619 | 0,6569 | 0,5269 | 0,8513 |
| 0,1740 | 0,5213 | 0,4260 | 0,6955 | 0,9646 | 0,3385 | 0,9322 | 0,7274 |

DRAFT

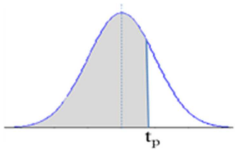
**Table 8 -** AREAS UNDER THE STANDARD NORMAL CURVE FROM 0 to z.




| z | 0,00 | 0,01 | 0,02 | 0,03 | 0,04 | 0,05 | 0,06 | 0,07 | 0,08 | 0,09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0,0 | 0,0000 | 0,0040 | 0,0080 | 0,0120 | 0,0160 | 0,0199 | 0,0239 | 0,0279 | 0,0319 | 0,0359 |
| 0,1 | 0,0398 | 0,0438 | 0,0478 | 0,0517 | 0,0557 | 0,0596 | 0,0636 | 0,0675 | 0,0714 | 0,0753 |
| 0,2 | 0,0793 | 0,0832 | 0,0871 | 0,0910 | 0,0948 | 0,0987 | 0,1026 | 0,1064 | 0,1103 | 0,1141 |
| 0,3 | 0,1179 | 0,1217 | 0,1255 | 0,1293 | 0,1331 | 0,1368 | 0,1406 | 0,1443 | 0,1480 | 0,1517 |
| 0,4 | 0,1554 | 0,1591 | 0,1628 | 0,1664 | 0,1700 | 0,1736 | 0,1772 | 0,1808 | 0,1844 | 0,1879 |
| 0,5 | 0,1915 | 0,1950 | 0,1985 | 0,2019 | 0,2054 | 0,2088 | 0,2123 | 0,2157 | 0,2190 | 0,2224 |
| 0,6 | 0,2257 | 0,2291 | 0,2324 | 0,2357 | 0,2389 | 0,2422 | 0,2454 | 0,2486 | 0,2517 | 0,2549 |
| 0,7 | 0,2580 | 0,2611 | 0,2642 | 0,2673 | 0,2704 | 0,2734 | 0,2764 | 0,2794 | 0,2823 | 0,2852 |
| 0,8 | 0,2881 | 0,2910 | 0,2939 | 0,2967 | 0,2995 | 0,3023 | 0,3051 | 0,3078 | 0,3106 | 0,3133 |
| 0,9 | 0,3159 | 0,3186 | 0,3212 | 0,3238 | 0,3264 | 0,3289 | 0,3315 | 0,3340 | 0,3365 | 0,3389 |
| 1,0 | 0,3413 | 0,3438 | 0,3461 | 0,3485 | 0,3508 | 0,3531 | 0,3554 | 0,3577 | 0,3599 | 0,3621 |
| 1,1 | 0,3643 | 0,3665 | 0,3686 | 0,3708 | 0,3729 | 0,3749 | 0,3770 | 0,3790 | 0,3810 | 0,3830 |
| 1,2 | 0,3849 | 0,3869 | 0,3888 | 0,3907 | 0,3925 | 0,3944 | 0,3962 | 0,3980 | 0,3997 | 0,4015 |
| 1,3 | 0,4032 | 0,4049 | 0,4066 | 0,4082 | 0,4099 | 0,4115 | 0,4131 | 0,4147 | 0,4162 | 0,4177 |
| 1,4 | 0,4192 | 0,4207 | 0,4222 | 0,4236 | 0,4251 | 0,4265 | 0,4279 | 0,4292 | 0,4306 | 0,4319 |
| 1,5 | 0,4332 | 0,4345 | 0,4357 | 0,4370 | 0,4382 | 0,4394 | 0,4406 | 0,4418 | 0,4429 | 0,4441 |
| 1,6 | 0,4452 | 0,4463 | 0,4474 | 0,4484 | 0,4495 | 0,4505 | 0,4515 | 0,4525 | 0,4535 | 0,4545 |
| 1,7 | 0,4554 | 0,4564 | 0,4573 | 0,4582 | 0,4591 | 0,4599 | 0,4608 | 0,4616 | 0,4625 | 0,4633 |
| 1,8 | 0,4641 | 0,4649 | 0,4656 | 0,4664 | 0,4671 | 0,4678 | 0,4686 | 0,4693 | 0,4699 | 0,4706 |
| 1,9 | 0,4713 | 0,4719 | 0,4726 | 0,4732 | 0,4738 | 0,4744 | 0,4750 | 0,4756 | 0,4761 | 0,4767 |
| 2,0 | 0,4772 | 0,4778 | 0,4783 | 0,4788 | 0,4793 | 0,4798 | 0,4803 | 0,4808 | 0,4812 | 0,4817 |
| 2,1 | 0,4821 | 0,4826 | 0,4830 | 0,4834 | 0,4838 | 0,4842 | 0,4846 | 0,4850 | 0,4854 | 0,4857 |
| 2,2 | 0,4861 | 0,4864 | 0,4868 | 0,4871 | 0,4875 | 0,4878 | 0,4881 | 0,4884 | 0,4887 | 0,4890 |
| 2,3 | 0,4893 | 0,4896 | 0,4898 | 0,4901 | 0,4904 | 0,4906 | 0,4909 | 0,4911 | 0,4913 | 0,4916 |
| 2,4 | 0,4918 | 0,4920 | 0,4922 | 0,4925 | 0,4927 | 0,4929 | 0,4931 | 0,4932 | 0,4934 | 0,4936 |
| 2,5 | 0,4938 | 0,4940 | 0,4941 | 0,4943 | 0,4945 | 0,4946 | 0,4948 | 0,4949 | 0,4951 | 0,4952 |
| 2,6 | 0,4953 | 0,4955 | 0,4956 | 0,4957 | 0,4959 | 0,4960 | 0,4961 | 0,4962 | 0,4963 | 0,4964 |
| 2,7 | 0,4965 | 0,4966 | 0,4967 | 0,4968 | 0,4969 | 0,4970 | 0,4971 | 0,4972 | 0,4973 | 0,4974 |
| 2,8 | 0,4974 | 0,4975 | 0,4976 | 0,4977 | 0,4977 | 0,4978 | 0,4979 | 0,4979 | 0,4980 | 0,4981 |
| 2,9 | 0,4981 | 0,4982 | 0,4982 | 0,4983 | 0,4984 | 0,4984 | 0,4985 | 0,4985 | 0,4986 | 0,4986 |
| 3,0 | 0,4987 | 0,4987 | 0,4987 | 0,4988 | 0,4988 | 0,4989 | 0,4989 | 0,4989 | 0,4990 | 0,4990 |
| 3,1 | 0,4990 | 0,4991 | 0,4991 | 0,4991 | 0,4992 | 0,4992 | 0,4992 | 0,4992 | 0,4993 | 0,4993 |
| 3,2 | 0,4993 | 0,4993 | 0,4994 | 0,4994 | 0,4994 | 0,4994 | 0,4994 | 0,4995 | 0,4995 | 0,4995 |
| 3,3 | 0,4995 | 0,4995 | 0,4995 | 0,4996 | 0,4996 | 0,4996 | 0,4996 | 0,4996 | 0,4996 | 0,4997 |
| 3,4 | 0,4997 | 0,4997 | 0,4997 | 0,4997 | 0,4997 | 0,4997 | 0,4997 | 0,4997 | 0,4997 | 0,4998 |
| 3,5 | 0,4998 | 0,4998 | 0,4998 | 0,4998 | 0,4998 | 0,4998 | 0,4998 | 0,4998 | 0,4998 | 0,4998 |
| 3,6 | 0,4998 | 0,4998 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 |
| 3,7 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 |
| 3,8 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 | 0,4999 |
| 3,9 | 0,5000 | 0,5000 | 0,5000 | 0,5000 | 0,5000 | 0,5000 | 0,5000 | 0,5000 | 0,5000 | 0,5000 |

DRAFT

## **Table 9 -** PERCENTILE VALUES (tp) FOR t-DISTRIBUTION




*v* degrees of freedom

| *v* | α = 0,005 | α = 0,001 | α = 0,025 | α = 0,05 | α = 0,10 | α = 0,20 | α = 0,25 | α = 0,30 | α = 0,40 | α = 0,45 |
|---|---|---|---|---|---|---|---|---|---|---|
| | $t_{0,995}$ | $t_{0,99}$ | $t_{0,975}$ | $t_{0,95}$ | $t_{0,90}$ | $t_{0,80}$ | $t_{0,75}$ | $t_{0,70}$ | $t_{0,60}$ | $t_{0,55}$ |
| 1 | 63,66 | 31,82 | 12,71 | 6,31 | 3,08 | 1,376 | 1,000 | 0,727 | 0,325 | 0,158 |
| 2 | 9,92 | 6,96 | 4,30 | 2,92 | 1,89 | 1,061 | 0,816 | 0,617 | 0,289 | 0,142 |
| 3 | 5,84 | 4,54 | 3,18 | 2,35 | 1,64 | 0,978 | 0,765 | 0,584 | 0,277 | 0,137 |
| 4 | 4,60 | 3,75 | 2,78 | 2,13 | 1,53 | 0,941 | 0,741 | 0,569 | 0,271 | 0,134 |
| 5 | 4,03 | 3,36 | 2,57 | 2,02 | 1,48 | 0,920 | 0,727 | 0,559 | 0,267 | 0,132 |
| 6 | 3,71 | 3,14 | 2,45 | 1,94 | 1,44 | 0,906 | 0,718 | 0,553 | 0,265 | 0,131 |
| 7 | 3,50 | 3,00 | 2,36 | 1,90 | 1,42 | 0,896 | 0,711 | 0,549 | 0,263 | 0,130 |
| 8 | 3,36 | 2,90 | 2,31 | 1,86 | 1,40 | 0,889 | 0,706 | 0,546 | 0,262 | 0,130 |
| 9 | 3,25 | 2,82 | 2,26 | 1,83 | 1,38 | 0,883 | 0,703 | 0,543 | 0,261 | 0,129 |
| 10 | 3,17 | 2,76 | 2,23 | 1,81 | 1,37 | 0,879 | 0,700 | 0,542 | 0,260 | 0,129 |
| 11 | 3,11 | 2,72 | 2,20 | 1,80 | 1,36 | 0,876 | 0,697 | 0,540 | 0,260 | 0,129 |
| 12 | 3,06 | 2,68 | 2,18 | 1,78 | 1,36 | 0,873 | 0,695 | 0,539 | 0,259 | 0,128 |
| 13 | 3,01 | 2,65 | 2,16 | 1,77 | 1,35 | 0,870 | 0,694 | 0,538 | 0,259 | 0,128 |
| 14 | 2,98 | 2,62 | 2,14 | 1,76 | 1,34 | 0,868 | 0,692 | 0,537 | 0,258 | 0,128 |
| 15 | 2,95 | 2,60 | 2,13 | 1,75 | 1,34 | 0,866 | 0,691 | 0,536 | 0,258 | 0,128 |
| 16 | 2,92 | 2,58 | 2,12 | 1,75 | 1,34 | 0,865 | 0,690 | 0,535 | 0,258 | 0,128 |
| 17 | 2,90 | 2,57 | 2,11 | 1,74 | 1,33 | 0,863 | 0,689 | 0,534 | 0,257 | 0,128 |
| 18 | 2,88 | 2,55 | 2,10 | 1,73 | 1,33 | 0,862 | 0,688 | 0,534 | 0,257 | 0,127 |
| 19 | 2,86 | 2,54 | 2,09 | 1,73 | 1,33 | 0,861 | 0,688 | 0,533 | 0,257 | 0,127 |
| 20 | 2,84 | 2,53 | 2,09 | 1,72 | 1,32 | 0,860 | 0,687 | 0,533 | 0,257 | 0,127 |
| 21 | 2,83 | 2,52 | 2,08 | 1,72 | 1,32 | 0,859 | 0,686 | 0,532 | 0,257 | 0,127 |
| 22 | 2,82 | 2,51 | 2,07 | 1,72 | 1,32 | 0,858 | 0,686 | 0,532 | 0,256 | 0,127 |
| 23 | 2,81 | 2,50 | 2,07 | 1,71 | 1,32 | 0,858 | 0,685 | 0,532 | 0,256 | 0,127 |
| 24 | 2,80 | 2,49 | 2,06 | 1,71 | 1,32 | 0,857 | 0,685 | 0,531 | 0,256 | 0,127 |
| 25 | 2,79 | 2,48 | 2,06 | 1,71 | 1,32 | 0,856 | 0,684 | 0,531 | 0,256 | 0,127 |
| 26 | 2,78 | 2,48 | 2,06 | 1,71 | 1,32 | 0,856 | 0,684 | 0,531 | 0,256 | 0,127 |
| 27 | 2,77 | 2,47 | 2,05 | 1,70 | 1,31 | 0,855 | 0,684 | 0,531 | 0,256 | 0,127 |
| 28 | 2,76 | 2,47 | 2,05 | 1,70 | 1,31 | 0,855 | 0,683 | 0,530 | 0,256 | 0,127 |
| 29 | 2,76 | 2,46 | 2,04 | 1,70 | 1,31 | 0,854 | 0,683 | 0,530 | 0,256 | 0,127 |
| 30 | 2,75 | 2,46 | 2,04 | 1,70 | 1,31 | 0,854 | 0,683 | 0,530 | 0,256 | 0,127 |
| 40 | 2,70 | 2,42 | 2,02 | 1,68 | 1,30 | 0,851 | 0,681 | 0,529 | 0,255 | 0,126 |
| 60 | 2,66 | 2,39 | 2,00 | 1,67 | 1,30 | 0,848 | 0,679 | 0,527 | 0,254 | 0,126 |
| 120 | 2,62 | 2,36 | 1,98 | 1,66 | 1,29 | 0,845 | 0,677 | 0,526 | 0,254 | 0,126 |

DRAFT

## **Table 10 (a) -** PERCENTAGE VALUES OF THE F-DISTRIBUTION

$f_{0,05\ v1\ v2}$

| | $v_1$ | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 | □ |
| 1 | 161 | 199 | 216 | 225 | 230 | 234 | 237 | 239 | 241 | 242 | 244 | 246 | 248 | 249 | 250 | 251 | 252 | 253 | 254 |
| 2 | 18,51 | 19,00 | 19,16 | 19,25 | 19,30 | 19,33 | 19,35 | 19,37 | 19,38 | 19,40 | 19,41 | 19,43 | 19,45 | 19,45 | 19,46 | 19,47 | 19,48 | 19,49 | 19,50 |
| 3 | 10,13 | 9,55 | 9,28 | 9,12 | 9,01 | 8,94 | 8,89 | 8,85 | 8,81 | 8,79 | 8,74 | 8,70 | 8,66 | 8,64 | 8,62 | 8,59 | 8,57 | 8,55 | 8,53 |
| 4 | 7,71 | 6,94 | 6,59 | 6,39 | 6,26 | 6,16 | 6,09 | 6,04 | 6,00 | 5,96 | 5,91 | 5,86 | 5,80 | 5,77 | 5,75 | 5,72 | 5,69 | 5,66 | 5,63 |
| 5 | 6,61 | 5,79 | 5,41 | 5,19 | 5,05 | 4,95 | 4,88 | 4,82 | 4,77 | 4,74 | 4,68 | 4,62 | 4,56 | 4,53 | 4,50 | 4,46 | 4,43 | 4,40 | 4,37 |
| 6 | 5,99 | 5,14 | 4,76 | 4,53 | 4,39 | 4,28 | 4,21 | 4,15 | 4,10 | 4,06 | 4,00 | 3,94 | 3,87 | 3,84 | 3,81 | 3,77 | 3,74 | 3,70 | 3,67 |
| 7 | 5,59 | 4,74 | 4,35 | 4,12 | 3,97 | 3,87 | 3,79 | 3,73 | 3,68 | 3,64 | 3,57 | 3,51 | 3,44 | 3,41 | 3,38 | 3,34 | 3,30 | 3,27 | 3,23 |
| 8 | 5,32 | 4,46 | 4,07 | 3,84 | 3,69 | 3,58 | 3,50 | 3,44 | 3,39 | 3,35 | 3,28 | 3,22 | 3,15 | 3,12 | 3,08 | 3,04 | 3,01 | 2,97 | 2,93 |
| 9 | 5,12 | 4,26 | 3,86 | 3,63 | 3,48 | 3,37 | 3,29 | 3,23 | 3,18 | 3,14 | 3,07 | 3,01 | 2,94 | 2,90 | 2,86 | 2,83 | 2,79 | 2,75 | 2,71 |
| 10 | 4,96 | 4,10 | 3,71 | 3,48 | 3,33 | 3,22 | 3,14 | 3,07 | 3,02 | 2,98 | 2,91 | 2,85 | 2,77 | 2,74 | 2,70 | 2,66 | 2,62 | 2,58 | 2,54 |
| 11 | 4,84 | 3,98 | 3,59 | 3,36 | 3,20 | 3,09 | 3,01 | 2,95 | 2,90 | 2,85 | 2,79 | 2,72 | 2,65 | 2,61 | 2,57 | 2,53 | 2,49 | 2,45 | 2,40 |
| 12 | 4,75 | 3,89 | 3,49 | 3,26 | 3,11 | 3,00 | 2,91 | 2,85 | 2,80 | 2,75 | 2,69 | 2,62 | 2,54 | 2,51 | 2,47 | 2,43 | 2,38 | 2,34 | 2,30 |
| 13 | 4,67 | 3,81 | 3,41 | 3,18 | 3,03 | 2,92 | 2,83 | 2,77 | 2,71 | 2,67 | 2,60 | 2,53 | 2,46 | 2,42 | 2,38 | 2,34 | 2,30 | 2,25 | 2,21 |
| 14 | 4,60 | 3,74 | 3,34 | 3,11 | 2,96 | 2,85 | 2,76 | 2,70 | 2,65 | 2,60 | 2,53 | 2,46 | 2,39 | 2,35 | 2,31 | 2,27 | 2,22 | 2,18 | 2,13 |
| 15 | 4,54 | 3,68 | 3,29 | 3,06 | 2,90 | 2,79 | 2,71 | 2,64 | 2,59 | 2,54 | 2,48 | 2,40 | 2,33 | 2,29 | 2,25 | 2,20 | 2,16 | 2,11 | 2,07 |
| 16 | 4,49 | 3,63 | 3,24 | 3,01 | 2,85 | 2,74 | 2,66 | 2,59 | 2,54 | 2,49 | 2,42 | 2,35 | 2,28 | 2,24 | 2,19 | 2,15 | 2,11 | 2,06 | 2,01 |
| 17 | 4,45 | 3,59 | 3,20 | 2,96 | 2,81 | 2,70 | 2,61 | 2,55 | 2,49 | 2,45 | 2,38 | 2,31 | 2,23 | 2,19 | 2,15 | 2,10 | 2,06 | 2,01 | 1,96 |
| 18 | 4,41 | 3,55 | 3,16 | 2,93 | 2,77 | 2,66 | 2,58 | 2,51 | 2,46 | 2,41 | 2,34 | 2,27 | 2,19 | 2,15 | 2,11 | 2,06 | 2,02 | 1,97 | 1,93 |
| 19 | 4,38 | 3,52 | 3,13 | 2,90 | 2,74 | 2,63 | 2,54 | 2,48 | 2,42 | 2,38 | 2,31 | 2,23 | 2,16 | 2,11 | 2,07 | 2,03 | 1,98 | 1,93 | 1,88 |
| 20 | 4,35 | 3,49 | 3,10 | 2,87 | 2,71 | 2,60 | 2,51 | 2,45 | 2,39 | 2,35 | 2,28 | 2,20 | 2,12 | 2,08 | 2,04 | 1,99 | 1,95 | 1,90 | 1,84 |
| 21 | 4,32 | 3,47 | 3,07 | 2,84 | 2,68 | 2,57 | 2,49 | 2,42 | 2,37 | 2,32 | 2,25 | 2,18 | 2,10 | 2,05 | 2,01 | 1,96 | 1,92 | 1,87 | 1,81 |
| 22 | 4,30 | 3,44 | 3,05 | 2,82 | 2,66 | 2,55 | 2,46 | 2,40 | 2,34 | 2,30 | 2,23 | 2,15 | 2,07 | 2,03 | 1,98 | 1,94 | 1,89 | 1,84 | 1,78 |
| 23 | 4,28 | 3,42 | 3,03 | 2,80 | 2,64 | 2,53 | 2,44 | 2,37 | 2,32 | 2,27 | 2,20 | 2,13 | 2,05 | 2,01 | 1,96 | 1,91 | 1,86 | 1,81 | 1,76 |
| 24 | 4,26 | 3,40 | 3,01 | 2,78 | 2,62 | 2,51 | 2,42 | 2,36 | 2,30 | 2,25 | 2,18 | 2,11 | 2,03 | 1,98 | 1,94 | 1,89 | 1,84 | 1,79 | 1,73 |
| 25 | 4,24 | 3,39 | 2,99 | 2,76 | 2,60 | 2,49 | 2,40 | 2,34 | 2,28 | 2,24 | 2,16 | 2,09 | 2,01 | 1,96 | 1,92 | 1,87 | 1,82 | 1,77 | 1,71 |
| 30 | 4,17 | 3,32 | 2,92 | 2,69 | 2,53 | 2,42 | 2,33 | 2,27 | 2,21 | 2,16 | 2,09 | 2,01 | 1,93 | 1,89 | 1,84 | 1,79 | 1,74 | 1,68 | 1,62 |
| 40 | 4,08 | 3,23 | 2,84 | 2,61 | 2,45 | 2,34 | 2,25 | 2,18 | 2,12 | 2,08 | 2,00 | 1,92 | 1,84 | 1,79 | 1,74 | 1,69 | 1,64 | 1,58 | 1,51 |
| 60 | 4,00 | 3,15 | 2,76 | 2,53 | 2,37 | 2,25 | 2,17 | 2,10 | 2,04 | 1,99 | 1,92 | 1,84 | 1,75 | 1,70 | 1,65 | 1,59 | 1,53 | 1,47 | 1,39 |
| 120 | 3,92 | 3,07 | 2,68 | 2,45 | 2,29 | 2,18 | 2,09 | 2,02 | 1,96 | 1,91 | 1,83 | 1,75 | 1,66 | 1,61 | 1,55 | 1,50 | 1,43 | 1,35 | 1,25 |
| ∞ | 3,84 | 3,00 | 2,60 | 2,37 | 2,21 | 2,10 | 2,01 | 1,94 | 1,88 | 1,83 | 1,75 | 1,67 | 1,57 | 1,52 | 1,46 | 1,39 | 1,32 | 1,22 | 1,00 |

DRAFT

## Table 10 (b) - PERCENTAGE VALUES OF THE F-DISTRIBUTION

$f_{0,01\ v1\ v2}$

| | $v_1$ | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $v_2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 | □ |
| 1 | 4052 | 4999 | 5403 | 5625 | 5764 | 5859 | 5928 | 5981 | 6022 | 6056 | 6106 | 6157 | 6209 | 6235 | 6261 | 6287 | 6313 | 6339 | 6366 |
| 2 | 98,50 | 99,00 | 99,17 | 99,25 | 99,30 | 99,33 | 99,36 | 99,37 | 99,39 | 99,40 | 99,42 | 99,43 | 99,45 | 99,46 | 99,47 | 99,47 | 99,48 | 99,49 | 99,50 |
| 3 | 34,12 | 30,82 | 29,46 | 28,71 | 28,24 | 27,91 | 27,67 | 27,49 | 27,35 | 27,23 | 27,05 | 26,87 | 26,69 | 26,60 | 26,50 | 26,41 | 26,32 | 26,22 | 26,10 |
| 4 | 21,20 | 18,00 | 16,69 | 15,98 | 15,52 | 15,21 | 14,98 | 14,80 | 14,66 | 14,55 | 14,37 | 14,20 | 14,02 | 13,93 | 13,84 | 13,75 | 13,65 | 13,56 | 13,50 |
| 5 | 16,26 | 13,27 | 12,06 | 11,39 | 10,97 | 10,67 | 10,46 | 10,29 | 10,16 | 10,05 | 9,89 | 9,72 | 9,55 | 9,47 | 9,38 | 9,29 | 9,20 | 9,11 | 9,02 |
| 6 | 13,75 | 10,92 | 9,78 | 9,15 | 8,75 | 8,47 | 8,26 | 8,10 | 7,98 | 7,87 | 7,72 | 7,56 | 7,40 | 7,31 | 7,23 | 7,14 | 7,06 | 6,97 | 6,88 |
| 7 | 12,25 | 9,55 | 8,45 | 7,85 | 7,46 | 7,19 | 6,99 | 6,84 | 6,72 | 6,62 | 6,47 | 6,31 | 6,16 | 6,07 | 5,99 | 5,91 | 5,82 | 5,74 | 5,65 |
| 8 | 11,26 | 8,65 | 7,59 | 7,01 | 6,63 | 6,37 | 6,18 | 6,03 | 5,91 | 5,81 | 5,67 | 5,52 | 5,36 | 5,28 | 5,20 | 5,12 | 5,03 | 4,95 | 4,83 |
| 9 | 10,56 | 8,02 | 6,99 | 6,42 | 6,06 | 5,80 | 5,61 | 5,47 | 5,35 | 5,26 | 5,11 | 4,96 | 4,81 | 4,73 | 4,65 | 4,57 | 4,48 | 4,40 | 4,31 |
| 10 | 10,04 | 7,56 | 6,55 | 5,99 | 5,64 | 5,39 | 5,20 | 5,06 | 4,94 | 4,85 | 4,71 | 4,56 | 4,41 | 4,33 | 4,25 | 4,17 | 4,08 | 4,00 | 3,91 |
| 11 | 9,65 | 7,21 | 6,22 | 5,67 | 5,32 | 5,07 | 4,89 | 4,74 | 4,63 | 4,54 | 4,40 | 4,25 | 4,10 | 4,02 | 3,94 | 3,86 | 3,78 | 3,69 | 3,60 |
| 12 | 9,33 | 6,93 | 5,95 | 5,41 | 5,06 | 4,82 | 4,64 | 4,50 | 4,39 | 4,30 | 4,16 | 4,01 | 3,86 | 3,78 | 3,70 | 3,62 | 3,54 | 3,45 | 3,36 |
| 13 | 9,07 | 6,70 | 5,74 | 5,21 | 4,86 | 4,62 | 4,44 | 4,30 | 4,19 | 4,10 | 3,96 | 3,82 | 3,66 | 3,59 | 3,51 | 3,43 | 3,34 | 3,25 | 3,17 |
| 14 | 8,86 | 6,51 | 5,56 | 5,04 | 4,69 | 4,46 | 4,28 | 4,14 | 4,03 | 3,94 | 3,80 | 3,66 | 3,51 | 3,43 | 3,35 | 3,27 | 3,18 | 3,09 | 3,00 |
| 15 | 8,68 | 6,36 | 5,42 | 4,89 | 4,56 | 4,32 | 4,14 | 4,00 | 3,89 | 3,80 | 3,67 | 3,52 | 3,37 | 3,29 | 3,21 | 3,13 | 3,05 | 2,96 | 2,87 |
| 16 | 8,53 | 6,23 | 5,29 | 4,77 | 4,44 | 4,20 | 4,03 | 3,89 | 3,78 | 3,69 | 3,55 | 3,41 | 3,26 | 3,18 | 3,10 | 3,02 | 2,93 | 2,84 | 2,75 |
| 17 | 8,40 | 6,11 | 5,18 | 4,67 | 4,34 | 4,10 | 3,93 | 3,79 | 3,68 | 3,59 | 3,46 | 3,31 | 3,16 | 3,08 | 3,00 | 2,92 | 2,83 | 2,75 | 2,65 |
| 18 | 8,29 | 6,01 | 5,09 | 4,58 | 4,25 | 4,01 | 3,84 | 3,71 | 3,60 | 3,51 | 3,37 | 3,23 | 3,08 | 3,00 | 2,92 | 2,84 | 2,75 | 2,66 | 2,57 |
| 19 | 8,18 | 5,93 | 5,01 | 4,50 | 4,17 | 3,94 | 3,77 | 3,63 | 3,52 | 3,43 | 3,30 | 3,15 | 3,00 | 2,92 | 2,84 | 2,76 | 2,67 | 2,58 | 2,49 |
| 20 | 8,10 | 5,85 | 4,94 | 4,43 | 4,10 | 3,87 | 3,70 | 3,56 | 3,46 | 3,37 | 3,23 | 3,09 | 2,94 | 2,86 | 2,78 | 2,69 | 2,61 | 2,52 | 2,42 |
| 21 | 8,02 | 5,78 | 4,87 | 4,37 | 4,04 | 3,81 | 3,64 | 3,51 | 3,40 | 3,31 | 3,17 | 3,03 | 2,88 | 2,80 | 2,72 | 2,64 | 2,55 | 2,46 | 2,36 |
| 22 | 7,95 | 5,72 | 4,82 | 4,31 | 3,99 | 3,76 | 3,59 | 3,45 | 3,35 | 3,26 | 3,12 | 2,98 | 2,83 | 2,75 | 2,67 | 2,58 | 2,50 | 2,40 | 2,31 |
| 23 | 7,88 | 5,66 | 4,76 | 4,26 | 3,94 | 3,71 | 3,54 | 3,41 | 3,30 | 3,21 | 3,07 | 2,93 | 2,78 | 2,70 | 2,62 | 2,54 | 2,45 | 2,35 | 2,26 |
| 24 | 7,82 | 5,61 | 4,72 | 4,22 | 3,90 | 3,67 | 3,50 | 3,36 | 3,26 | 3,17 | 3,03 | 2,89 | 2,74 | 2,66 | 2,58 | 2,49 | 2,40 | 2,31 | 2,21 |
| 25 | 7,77 | 5,57 | 4,68 | 4,18 | 3,85 | 3,63 | 3,46 | 3,32 | 3,22 | 3,13 | 2,99 | 2,85 | 2,70 | 2,62 | 2,54 | 2,45 | 2,36 | 2,27 | 2,17 |
| 30 | 7,56 | 5,39 | 4,51 | 4,02 | 3,70 | 3,47 | 3,30 | 3,17 | 3,07 | 2,98 | 2,84 | 2,70 | 2,55 | 2,47 | 2,39 | 2,30 | 2,21 | 2,11 | 2,01 |
| 40 | 7,31 | 5,18 | 4,31 | 3,83 | 3,51 | 3,29 | 3,12 | 2,99 | 2,89 | 2,80 | 2,66 | 2,52 | 2,37 | 2,29 | 2,20 | 2,11 | 2,02 | 1,92 | 1,80 |
| 60 | 7,08 | 4,98 | 4,13 | 3,65 | 3,34 | 3,12 | 2,95 | 2,82 | 2,72 | 2,63 | 2,50 | 2,35 | 2,20 | 2,12 | 2,03 | 1,94 | 1,84 | 1,73 | 1,60 |
| 120 | 6,85 | 4,79 | 3,95 | 3,48 | 3,17 | 2,96 | 2,79 | 2,66 | 2,56 | 2,47 | 2,34 | 2,19 | 2,03 | 1,95 | 1,86 | 1,76 | 1,66 | 1,53 | 1,38 |
| ∞ | 6,63 | 4,61 | 3,78 | 3,32 | 3,02 | 2,80 | 2,64 | 2,51 | 2,41 | 2,32 | 2,18 | 2,04 | 1,88 | 1,79 | 1,70 | 1,59 | 1,47 | 1,32 | 1,00 |

DRAFT

## Table 11 (a) - ERROR AND UNCERTAINTY

| Material or Product | Category | Property | Unit | Maximum permissible error E | Uncertainty (σ) |
|---|---|---|---|---|---|
| Asphalt | Densification | Density (Marshall) | $kg/m^3$ | 5,0 | 7 |
| | | Compaction (Marshall) | % | 2,0 | 2,5 |
| | | Density (Rice) | $kg/m^3$ | 3,5 | 5 |
| | | Compaction (Rice) | % | 2,0 | 2 |
| | | Density - core | $kg/m^3$ | | 7 |
| | Gradation (percent passing) | 13,2 mm | % | 2,5 | 3 |
| | | 9,5 mm | % | 2,5 | 3 |
| | | 4,75 mm | % | 1,8 | 2 |
| | | 2,36 mm | % | 1,5 | 2 |
| | | 0,30 mm | % | 1,0 | 2 |
| | | 0,075 mm | % | 0,5 | 1 |
| | Miscellaneous | Binder content | % | 0,2 | 0,3 |
| | | Voids in mix | % | 0,8 | 1 |
| Concrete | Cube strength (Mpa)[3] | Small structures (small culverts) | MPa | 5 | 7* |
| | | Medium size structures (small bridges) | MPa | 4,5 | 6* |
| | | Large structures | MPa | 3 | 5* |
| | Coarse aggregate | 37,5 mm | % | 2,5 | 3 |
| | | 26,5 mm | % | 3 | 5 |
| | | 19,0 mm | % | 3 | 5 |
| | | 13,2 mm | % | 2,5 | 4 |
| | | 9,5 mm | % | 2,5 | 3 |
| | | 6,7 mm | % | 2,5 | 3 |
| | Fine aggregate | 4,75 mm | % | 2 | 3 |
| | | 2,36 mm | % | 2 | 3 |
| | | 1,18 mm | % | 2 | 3 |
| | | 0,600 mm | % | 1,8 | 2 |
| | | 0,425 mm | % | 1,8 | 2 |
| | | 0,300 mm | % | 1,8 | 2 |
| | | 0,150 mm | % | 1,2 | 1,5 |
| | | 0,075 mm | % | 1 | 1 |

[3] Fulton's Concrete Technology, 8th edition, 2001

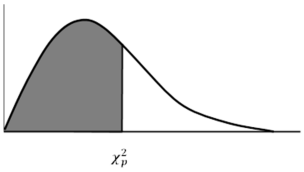
## **Table (b) -** ERROR AND UNCERTAINTY

| Material or Product | Category | Property | Unit | Maximum permissible error E | Uncertainty (σ) |
|---|---|---|---|---|---|
| Layer (G1, G2 & G3) | Densification | Density – Nuclear | $kg/m^3$ | 35 | 45 |
| | | Compaction | % | 1,5 | 2 |
| | Gradation (percent passing) | 26,5 mm | % | 1,5 | 2 |
| | | 19,5 mm | % | 2,5 | 5 |
| | | 13,2 mm | % | 2 | 3 |
| | | 4,75 mm | % | 2 | 3 |
| | | 2,0 mm | % | 1,5 | 2 |
| | | 0,425 mm | % | 1,5 | 2 |
| | | 0,075 mm | % | 1 | 1 |
| | Atterberg Limits | L.L. | % | 1 | 1,5 |
| | | P.L. | % | 1 | 1,5 |
| | | P.I. | % | 2 | 2 |
| | | L.S. | % | 0,5 | 1 |
| Layer (G4, G5 & G6) | Densification | Density – Nuclear | $kg/m^3$ | 37 | 48 |
| | | Compaction | % | 1,7 | 2,3 |
| | Gradation (percent passing) | 26,5 mm | % | 3 | 5 |
| | | 19,5 mm | % | 2,5 | 5 |
| | | 13,2 mm | % | 3,5 | 5 |
| | | 4,75 mm | % | 2,5 | 4 |
| | | 2,0 mm | % | 2 | 3 |
| | | 0,425 mm | % | 1,8 | 2 |
| | | 0,075 mm | % | 1,2 | 2 |
| | Atterberg limits | L.L. | % | 1,5 | 2 |
| | | P.L. | % | 2 | 2,5 |
| | | P.I. | % | 2,5 | 3 |
| | | L.S. | % | 1,5 | 2 |
| Layer (G7, G8 & G9) | Densification | Density – Nuclear | | 40 | 50 |
| | | Compaction | | 2 | 2,5 |
| | Gradation (percent passing) | 26,5 mm | | 3,5 | 5 |
| | | 19,5 mm | | 3 | 5 |
| | | 13,2 mm | | 3,5 | 5 |
| | | 4,75 mm | | 3 | 4 |
| | | 2,0 mm | | 2,5 | 3 |
| | | 0,425 mm | | 2 | 2,5 |
| | | 0,075 mm | | 1,8 | 2 |
| | Atterberg limits | L.L. | | 1,8 | 2,5 |
| | | P.L. | | 2 | 2,5 |
| | | P.I. | % | 2,5 | 3 |
| | | L.S. | % | 1,5 | 2 |

## **Table -** ERROR AND UNCERTAINTY

| Material or Product | Category | Property | Unit | Maximum permissible error E | Uncertainty (σ) |
|---|---|---|---|---|---|
| Layer (G10) | Densification | Density – Nuclear | $kg/m^3$ | 35 | 55 |
| | | Compaction | % | 2 | 2,5 |
| | Gradation (percent passing) | 26,5 mm | % | 3 | 5 |
| | | 19,5 mm | % | 3 | 5 |
| | | 13,2 mm | % | 3,5 | 5 |
| | | 4,75 mm | % | 2,5 | 4 |
| | | 2,0 mm | % | 2 | 4 |
| | | 0,425 mm | % | 2 | 3 |
| | | 0,075 mm | % | 1,5 | 2,5 |
| | Atterberg limits | L.L. | % | 1,5 | 2,7 |
| | | P.L. | % | 2 | 2,7 |
| | | P.I. | % | 2,5 | 3,5 |
| | | L.S. | % | 1,5 | 2 |
| Surfacing aggregate | Gradation (percent passing) | 26,5 mm | % | 2,5 | 2,5 |
| | | 19,5 mm | % | 2,5 | 2,5 |
| | | 13,2 mm | % | 2,5 | 2,5 |
| | | 9,5 mm | % | 2,5 | 2,5 |
| | | 6,7 mm | % | 2 | 2 |
| | | 4,75 mm | % | 2 | 2 |
| | | 3,35 mm | % | 1,5 | 1,5 |
| | | 2,36 mm | % | 1,5 | 1,5 |
| | | 1,18 mm | % | 1,5 | 1,5 |
| | | 0,600 mm | % | 0,8 | 1 |
| | | 0,300 mm | % | 0,8 | 1 |
| | | 0,150 mm | % | 0,8 | 1 |
| | | 0,075 mm | % | 0,5 | 0,5 |
| | Miscellaneous | Flakiness index | % | 1,5 | 2 |
| | | A.L.D. measured Same test portion | mm | 0,5 | 0,5 |
| | | A.L.D. measured Different test portion | mm | 0,7 | 1 |

## **Table 12 -** PERCENTILE VALUES ($\chi^2_P$) FOR THE CHI-SQUARE DISTRIBUTION




With ν Degrees of Freedom

Shaded area = $p$

| ν | $\chi^2_{.995}$ | $\chi^2_{.99}$ | $\chi^2_{.975}$ | $\chi^2_{.95}$ | $\chi^2_{.90}$ | $\chi^2_{.10}$ | $\chi^2_{.05}$ | $\chi^2_{.025}$ | $\chi^2_{.01}$ | $\chi^2_{.005}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.88 | 6.64 | 5.02 | 3.84 | 2.71 | 0.0158 | 0.0040 | 0.0010 | 0.0002 | 0.0000 |
| 2 | 10.6 | 9.21 | 7.38 | 5.99 | 4.61 | 0.211 | 0.103 | 0.0506 | 0.0201 | 0.0100 |
| 3 | 12.8 | 11.3 | 9.35 | 7.82 | 6.25 | 0.584 | 0.352 | 0.216 | 0.115 | 0.072 |
| 4 | 14.9 | 13.3 | 11.1 | 9.49 | 7.78 | 1.06 | 0.711 | 0.484 | 0.297 | 0.207 |
| 5 | 16.8 | 15.1 | 12.8 | 11.1 | 9.24 | 1.61 | 1.15 | 0.831 | 0.554 | 0.412 |
| 6 | 18.5 | 16.8 | 14.4 | 12.6 | 10.6 | 2.20 | 1.64 | 1.24 | 0.872 | 0.676 |
| 7 | 20.3 | 18.5 | 16.0 | 14.1 | 12.0 | 2.83 | 2.17 | 1.69 | 1.24 | 0.989 |
| 8 | 22.0 | 20.1 | 17.5 | 15.5 | 13.4 | 3.49 | 2.73 | 2.18 | 1.65 | 1.34 |
| 9 | 23.6 | 21.7 | 19.0 | 16.9 | 14.7 | 4.17 | 3.33 | 2.70 | 2.09 | 1.74 |
| 10 | 25.2 | 23.2 | 20.5 | 18.3 | 16.0 | 4.87 | 3.94 | 3.25 | 2.56 | 2.16 |
| 11 | 26.8 | 24.7 | 21.9 | 19.7 | 17.3 | 5.58 | 4.58 | 3.82 | 3.05 | 2.60 |
| 12 | 28.3 | 26.2 | 23.3 | 21.0 | 18.5 | 6.30 | 5.23 | 4.40 | 3.57 | 3.07 |
| 13 | 29.8 | 27.7 | 24.7 | 22.4 | 19.8 | 7.04 | 5.89 | 5.01 | 4.11 | 3.57 |
| 14 | 31.3 | 29.1 | 26.1 | 23.7 | 21.1 | 7.79 | 6.57 | 5.63 | 4.66 | 4.08 |
| 15 | 32.8 | 30.6 | 27.5 | 1.0 | 22.3 | 8.55 | 7.26 | 6.26 | 5.23 | 4.60 |
| 16 | 34.3 | 32.0 | 28.8 | 26.3 | 23.5 | 9.31 | 7.96 | 6.91 | 5.81 | 5.14 |
| 17 | 35.7 | 33.4 | 30.2 | 27.6 | 24.8 | 10.1 | 8.67 | 7.56 | 6.41 | 5.70 |
| 18 | 37.2 | 34.8 | 31.5 | 28.9 | 26.0 | 10.9 | 9.39 | 8.23 | 7.02 | 6.27 |
| 19 | 38.6 | 36.2 | 32.9 | 30.1 | 27.2 | 11.7 | 10.1 | 8.91 | 7.63 | 6.84 |
| 20 | 40.0 | 37.6 | 34.2 | 31.4 | 28.4 | 12.4 | 10.9 | 9.59 | 8.26 | 7.43 |
| 21 | 41.4 | 38.9 | 35.5 | 32.7 | 29.6 | 13.2 | 11.6 | 10.3 | 8.90 | 8.03 |
| 22 | 42.8 | 40.3 | 36.8 | 33.9 | 30.8 | 14.0 | 12.3 | 11.0 | 9.54 | 8.64 |
| 23 | 44.2 | 41.6 | 38.1 | 35.2 | 32.0 | 14.8 | 13.1 | 11.7 | 10.2 | 9.26 |
| 24 | 45.6 | 43.0 | 39.4 | 36.4 | 33.2 | 15.7 | 13.8 | 12.4 | 10.9 | 9.89 |
| 25 | 46.9 | 44.3 | 40.6 | 37.7 | 34.4 | 16.5 | 14.6 | 13.1 | 11.5 | 10.5 |
| 26 | 48.3 | 45.6 | 41.9 | 38.9 | 35.6 | 17.3 | 15.4 | 13.8 | 12.2 | 11.2 |
| 27 | 49.6 | 47.0 | 43.2 | 40.1 | 36.7 | 18.1 | 16.2 | 14.6 | 12.9 | 11.8 |
| 28 | 51.0 | 48.3 | 44.5 | 41.3 | 37.9 | 18.9 | 16.9 | 15.3 | 13.6 | 12.5 |
| 29 | 52.3 | 49.6 | 45.7 | 42.6 | 39.1 | 19.8 | 17.7 | 16.0 | 14.3 | 13.1 |
| 30 | 53.7 | 50.9 | 47.0 | 43.8 | 40.3 | 20.6 | 18.5 | 16.8 | 15.0 | 13.8 |
| 40 | 66.8 | 63.7 | 59.3 | 55.8 | 51.8 | 29.1 | 26.5 | 24.4 | 22.2 | 20.7 |
| 50 | 79.5 | 76.2 | 71.4 | 67.5 | 63.2 | 37.7 | 34.8 | 32.4 | 29.7 | 28.0 |
| 60 | 92.0 | 88.4 | 83.3 | 79.1 | 74.4 | 46.5 | 43.2 | 40.5 | 37.5 | 35.5 |
| 70 | 104.2 | 100.4 | 95.0 | 90.5 | 85.5 | 55.3 | 51.7 | 48.8 | 45.4 | 43.3 |
| 80 | 116.3 | 112.3 | 106.6 | 101.9 | 96.6 | 64.3 | 60.4 | 57.2 | 53.5 | 51.2 |
| 90 | 128.3 | 124.1 | 118.1 | 113.1 | 107.6 | 73.3 | 69.1 | 65.6 | 61.8 | 59.2 |
| 100 | 140.2 | 135.8 | 129.6 | 124.3 | 118.5 | 82.4 | 77.9 | 74.2 | 70.1 | 67.3 |

**Table 13 -** CRITICAL VALUES FOR $C_{0,01;\,n}$

| $n$ | $C$ | $n$ | $C$ |
|---|---|---|---|
| 3 | 2,22 | 7 | 2,76 |
| 4 | 2,43 | 8 | 2,83 |
| 5 | 2,57 | 9 | 2,88 |
| 6 | 2,68 | $> 9$ | 2,90 |

## **Table 14 (a)** - $F_A$-VALUES FOR SINGLE LIMIT SPECIFICATION.

(α = 5%)

| n | φ-value | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 12 | 14 | 15 | 16 | 18 | 20 | 25 |
| 3 | 0,337 | 0,237 | 0,143 | 0,096 | 0,051 | -0,040 | -0,132 | -0,374 |
| 4 | 0,445 | 0,350 | 0,262 | 0,220 | 0,179 | 0,099 | 0,021 | -0,171 |
| 5 | 0,520 | 0,426 | 0,341 | 0,300 | 0,260 | 0,184 | 0,110 | -0,066 |
| 6 | 0,576 | 0,483 | 0,398 | 0,358 | 0,319 | 0,244 | 0,173 | 0,003 |
| 7 | 0,620 | 0,527 | 0,443 | 0,403 | 0,365 | 0,291 | 0,221 | 0,055 |
| 8 | 0,656 | 0,563 | 0,479 | 0,440 | 0,401 | 0,328 | 0,258 | 0,095 |
| 9 | 0,687 | 0,594 | 0,510 | 0,470 | 0,432 | 0,359 | 0,290 | 0,128 |
| 10 | 0,713 | 0,620 | 0,535 | 0,496 | 0,458 | 0,385 | 0,316 | 0,155 |
| 11 | 0,735 | 0,642 | 0,558 | 0,518 | 0,480 | 0,408 | 0,339 | 0,179 |
| 12 | 0,755 | 0,662 | 0,577 | 0,538 | 0,500 | 0,427 | 0,359 | 0,199 |
| 13 | 0,773 | 0,679 | 0,595 | 0,555 | 0,517 | 0,445 | 0,376 | 0,217 |
| 14 | 0,789 | 0,695 | 0,610 | 0,571 | 0,533 | 0,460 | 0,392 | 0,233 |
| 15 | 0,803 | 0,709 | 0,625 | 0,585 | 0,547 | 0,474 | 0,406 | 0,247 |
| 16 | 0,817 | 0,722 | 0,637 | 0,598 | 0,560 | 0,487 | 0,419 | 0,260 |
| 17 | 0,829 | 0,734 | 0,649 | 0,610 | 0,571 | 0,499 | 0,430 | 0,272 |
| 18 | 0,840 | 0,745 | 0,660 | 0,620 | 0,582 | 0,509 | 0,441 | 0,283 |
| 19 | 0,850 | 0,755 | 0,670 | 0,630 | 0,592 | 0,519 | 0,451 | 0,293 |
| 20 | 0,859 | 0,765 | 0,679 | 0,639 | 0,601 | 0,528 | 0,460 | 0,302 |
| 21 | 0,868 | 0,773 | 0,688 | 0,648 | 0,610 | 0,537 | 0,468 | 0,310 |
| 22 | 0,877 | 0,781 | 0,696 | 0,656 | 0,618 | 0,545 | 0,476 | 0,318 |
| 23 | 0,885 | 0,789 | 0,704 | 0,664 | 0,625 | 0,552 | 0,484 | 0,326 |
| 24 | 0,892 | 0,796 | 0,711 | 0,671 | 0,632 | 0,559 | 0,491 | 0,333 |
| 25 | 0,899 | 0,803 | 0,717 | 0,677 | 0,639 | 0,566 | 0,497 | 0,339 |
| 26 | 0,905 | 0,810 | 0,724 | 0,684 | 0,645 | 0,572 | 0,503 | 0,346 |
| 27 | 0,912 | 0,816 | 0,730 | 0,690 | 0,651 | 0,578 | 0,509 | 0,351 |
| 28 | 0,918 | 0,821 | 0,735 | 0,695 | 0,657 | 0,584 | 0,515 | 0,357 |
| 29 | 0,923 | 0,827 | 0,741 | 0,701 | 0,662 | 0,589 | 0,520 | 0,362 |
| 30 | 0,928 | 0,832 | 0,746 | 0,706 | 0,667 | 0,594 | 0,525 | 0,367 |

## **Table 14 (b) -** $F_R$ VALUES FOR SINGLE LIMIT SPECIFICATION.

(α = 1%)

| n | φ-value | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 12 | 14 | 15 | 16 | 18 | 20 | 25 |
| 4 | 0,123 | 0,013 | -0,095 | -0,148 | -0,202 | -0,312 | -0,428 | -0,762 |
| 5 | 0,238 | 0,137 | 0,042 | -0,004 | -0,050 | -0,140 | -0,231 | -0,463 |
| 6 | 0,320 | 0,223 | 0,132 | 0,089 | 0,047 | -0,037 | -0,118 | -0,321 |
| 7 | 0,382 | 0,287 | 0,199 | 0,158 | 0,117 | 0,037 | -0,040 | -0,228 |
| 8 | 0,432 | 0,338 | 0,252 | 0,211 | 0,171 | 0,094 | 0,020 | -0,160 |
| 9 | 0,474 | 0,381 | 0,295 | 0,255 | 0,216 | 0,140 | 0,067 | -0,107 |
| 10 | 0,509 | 0,416 | 0,332 | 0,292 | 0,253 | 0,178 | 0,107 | -0,064 |
| 11 | 0,540 | 0,447 | 0,363 | 0,323 | 0,285 | 0,211 | 0,140 | -0,028 |
| 12 | 0,567 | 0,474 | 0,390 | 0,351 | 0,312 | 0,239 | 0,169 | 0,003 |
| 13 | 0,590 | 0,498 | 0,414 | 0,375 | 0,337 | 0,264 | 0,194 | 0,030 |
| 14 | 0,612 | 0,520 | 0,436 | 0,397 | 0,359 | 0,286 | 0,216 | 0,053 |
| 15 | 0,631 | 0,539 | 0,455 | 0,416 | 0,378 | 0,305 | 0,236 | 0,074 |
| 16 | 0,649 | 0,557 | 0,473 | 0,434 | 0,396 | 0,323 | 0,254 | 0,093 |
| 17 | 0,665 | 0,573 | 0,489 | 0,450 | 0,412 | 0,339 | 0,271 | 0,110 |
| 18 | 0,680 | 0,587 | 0,504 | 0,465 | 0,427 | 0,354 | 0,286 | 0,126 |
| 19 | 0,694 | 0,601 | 0,517 | 0,478 | 0,440 | 0,368 | 0,300 | 0,140 |
| 20 | 0,706 | 0,614 | 0,530 | 0,491 | 0,453 | 0,381 | 0,312 | 0,153 |
| 21 | 0,718 | 0,626 | 0,542 | 0,503 | 0,465 | 0,393 | 0,324 | 0,165 |
| 22 | 0,729 | 0,637 | 0,553 | 0,513 | 0,476 | 0,404 | 0,335 | 0,177 |
| 23 | 0,740 | 0,647 | 0,563 | 0,524 | 0,486 | 0,414 | 0,346 | 0,187 |
| 24 | 0,750 | 0,657 | 0,573 | 0,533 | 0,496 | 0,423 | 0,355 | 0,197 |
| 25 | 0,759 | 0,666 | 0,582 | 0,542 | 0,505 | 0,432 | 0,364 | 0,206 |
| 26 | 0,768 | 0,674 | 0,590 | 0,551 | 0,513 | 0,441 | 0,373 | 0,215 |
| 27 | 0,776 | 0,683 | 0,599 | 0,559 | 0,521 | 0,449 | 0,381 | 0,223 |
| 28 | 0,784 | 0,690 | 0,606 | 0,567 | 0,529 | 0,457 | 0,389 | 0,231 |
| 29 | 0,791 | 0,698 | 0,614 | 0,574 | 0,536 | 0,464 | 0,396 | 0,238 |
| 30 | 0,799 | 0,705 | 0,621 | 0,581 | 0,543 | 0,471 | 0,403 | 0,245 |

## **Table 14 (c) -** $F_A$-VALUES FOR DOUBLE LIMIT SPECIFICATION

(α = 5%)

| n | φ-value | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 12 | 14 | 15 | 16 | 18 | 20 | 25 |
| 4 | 0,299 | 0,199 | 0,106 | 0,061 | 0,016 | -0,073 | -0,161 | -0,387 |
| 5 | 0,390 | 0,294 | 0,206 | 0,163 | 0,122 | 0,041 | -0,038 | -0,232 |
| 6 | 0,456 | 0,362 | 0,276 | 0,235 | 0,195 | 0,118 | 0,043 | -0,137 |
| 7 | 0,508 | 0,415 | 0,330 | 0,290 | 0,251 | 0,175 | 0,103 | -0,070 |
| 8 | 0,551 | 0,458 | 0,374 | 0,334 | 0,295 | 0,221 | 0,150 | -0,019 |
| 9 | 0,586 | 0,494 | 0,410 | 0,370 | 0,332 | 0,258 | 0,188 | 0,022 |
| 10 | 0,617 | 0,524 | 0,440 | 0,401 | 0,363 | 0,289 | 0,220 | 0,056 |
| 11 | 0,643 | 0,551 | 0,467 | 0,427 | 0,389 | 0,316 | 0,247 | 0,085 |
| 12 | 0,666 | 0,574 | 0,490 | 0,451 | 0,412 | 0,340 | 0,271 | 0,109 |
| 13 | 0,687 | 0,594 | 0,510 | 0,471 | 0,433 | 0,361 | 0,292 | 0,131 |
| 14 | 0,705 | 0,613 | 0,529 | 0,489 | 0,451 | 0,379 | 0,310 | 0,150 |
| 15 | 0,722 | 0,629 | 0,545 | 0,506 | 0,468 | 0,396 | 0,327 | 0,168 |
| 16 | 0,737 | 0,644 | 0,560 | 0,521 | 0,483 | 0,411 | 0,342 | 0,183 |
| 17 | 0,751 | 0,658 | 0,574 | 0,535 | 0,497 | 0,424 | 0,356 | 0,197 |
| 18 | 0,764 | 0,671 | 0,587 | 0,547 | 0,509 | 0,437 | 0,369 | 0,210 |
| 19 | 0,776 | 0,683 | 0,598 | 0,559 | 0,521 | 0,449 | 0,380 | 0,222 |
| 20 | 0,787 | 0,694 | 0,609 | 0,570 | 0,532 | 0,459 | 0,391 | 0,233 |
| 21 | 0,798 | 0,704 | 0,619 | 0,580 | 0,542 | 0,470 | 0,401 | 0,243 |
| 22 | 0,807 | 0,713 | 0,629 | 0,589 | 0,551 | 0,479 | 0,411 | 0,253 |
| 23 | 0,816 | 0,722 | 0,638 | 0,598 | 0,560 | 0,488 | 0,419 | 0,262 |
| 24 | 0,825 | 0,731 | 0,646 | 0,606 | 0,568 | 0,496 | 0,428 | 0,270 |
| 25 | 0,833 | 0,739 | 0,654 | 0,614 | 0,576 | 0,504 | 0,435 | 0,278 |
| 26 | 0,841 | 0,746 | 0,661 | 0,621 | 0,583 | 0,511 | 0,443 | 0,285 |
| 27 | 0,848 | 0,753 | 0,668 | 0,628 | 0,590 | 0,518 | 0,449 | 0,292 |
| 28 | 0,855 | 0,760 | 0,675 | 0,635 | 0,597 | 0,524 | 0,456 | 0,298 |
| 29 | 0,861 | 0,766 | 0,681 | 0,641 | 0,603 | 0,531 | 0,462 | 0,305 |
| 30 | 0,867 | 0,772 | 0,687 | 0,647 | 0,609 | 0,536 | 0,468 | 0,311 |

## **Table 14 (d) -** $F_R$ VALUES FOR DOUBLE LIMIT SPECIFICATION

(α = 1%)

| n | φ-value | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 12 | 14 | 15 | 16 | 18 | 20 | 25 |
| 4 | -0,007 | -0,132 | -0,258 | -0,324 | -0,392 | -0,538 | -0,707 | -1,430 |
| 5 | 0,132 | 0,024 | -0,079 | -0,130 | -0,181 | -0,283 | -0,389 | -0,675 |
| 6 | 0,226 | 0,125 | 0,030 | -0,016 | -0,061 | -0,151 | -0,240 | -0,468 |
| 7 | 0,296 | 0,199 | 0,108 | 0,064 | 0,022 | -0,062 | -0,144 | -0,348 |
| 8 | 0,352 | 0,257 | 0,168 | 0,126 | 0,085 | 0,005 | -0,073 | -0,264 |
| 9 | 0,398 | 0,304 | 0,217 | 0,176 | 0,136 | 0,058 | -0,018 | -0,200 |
| 10 | 0,437 | 0,344 | 0,258 | 0,217 | 0,178 | 0,101 | 0,028 | -0,149 |
| 11 | 0,471 | 0,378 | 0,293 | 0,253 | 0,214 | 0,138 | 0,066 | -0,107 |
| 12 | 0,500 | 0,408 | 0,323 | 0,283 | 0,244 | 0,170 | 0,098 | -0,072 |
| 13 | 0,526 | 0,434 | 0,350 | 0,310 | 0,272 | 0,198 | 0,127 | -0,041 |
| 14 | 0,550 | 0,458 | 0,374 | 0,334 | 0,296 | 0,222 | 0,152 | -0,014 |
| 15 | 0,571 | 0,479 | 0,395 | 0,356 | 0,317 | 0,244 | 0,174 | 0,010 |
| 16 | 0,590 | 0,498 | 0,414 | 0,375 | 0,337 | 0,264 | 0,194 | 0,031 |
| 17 | 0,608 | 0,516 | 0,432 | 0,393 | 0,355 | 0,282 | 0,213 | 0,050 |
| 18 | 0,624 | 0,532 | 0,448 | 0,409 | 0,371 | 0,299 | 0,229 | 0,068 |
| 19 | 0,639 | 0,547 | 0,463 | 0,424 | 0,386 | 0,314 | 0,245 | 0,084 |
| 20 | 0,653 | 0,561 | 0,477 | 0,438 | 0,400 | 0,328 | 0,259 | 0,098 |
| 21 | 0,666 | 0,574 | 0,490 | 0,451 | 0,413 | 0,341 | 0,272 | 0,112 |
| 22 | 0,678 | 0,586 | 0,502 | 0,463 | 0,425 | 0,353 | 0,284 | 0,125 |
| 23 | 0,689 | 0,597 | 0,513 | 0,474 | 0,436 | 0,364 | 0,296 | 0,136 |
| 24 | 0,700 | 0,607 | 0,524 | 0,485 | 0,447 | 0,375 | 0,306 | 0,147 |
| 25 | 0,710 | 0,617 | 0,534 | 0,495 | 0,457 | 0,385 | 0,317 | 0,158 |
| 26 | 0,720 | 0,627 | 0,543 | 0,504 | 0,466 | 0,394 | 0,326 | 0,167 |
| 27 | 0,729 | 0,636 | 0,552 | 0,513 | 0,475 | 0,403 | 0,335 | 0,176 |
| 28 | 0,737 | 0,644 | 0,561 | 0,521 | 0,484 | 0,411 | 0,343 | 0,185 |
| 29 | 0,745 | 0,652 | 0,569 | 0,529 | 0,492 | 0,419 | 0,351 | 0,193 |
| 30 | 0,753 | 0,660 | 0,576 | 0,537 | 0,499 | 0,427 | 0,359 | 0,201 |

## **Table 15 -** CONTROL CHART CONSTANTS

| Sample size | $\bar{X}$ - Chart | | | $R$ - Chart | | | | |
|---|---|---|---|---|---|---|---|---|
| | Factors for control limits | | | Factors for central line | Factors for control limits | | | |
| n | A | $A_1$ | $A_2$ | $d_2$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ |
| 2 | 2,121 | 3,760 | 1,880 | 1,128 | 0 | 3,686 | 0 | 3,267 |
| 3 | 1,732 | 2,394 | 1,023 | 1,693 | 0 | 4,358 | 0 | 2,575 |
| 4 | 1,500 | 1,880 | 0,729 | 2,059 | 0 | 4,698 | 0 | 2,282 |
| 5 | 1,342 | 1,596 | 0,577 | 2,326 | 0 | 4,918 | 0 | 2,115 |
| 6 | 1,225 | 1,410 | 0,483 | 2,534 | 0 | 5,078 | 0 | 2,004 |
| 7 | 1,134 | 1,277 | 0,419 | 2,704 | 0,205 | 5,203 | 0,076 | 1,924 |
| 8 | 1,061 | 1,175 | 0,373 | 2,847 | 0,387 | 5,307 | 0,136 | 1,864 |
| 9 | 1,000 | 1,094 | 0,337 | 2,970 | 0,546 | 5,394 | 0,184 | 1,816 |
| 10 | 0,949 | 1,028 | 0,308 | 3,078 | 0,687 | 5,469 | 0,223 | 1,777 |
| 11 | 0,905 | 0,973 | 0,285 | 3,173 | 0,812 | 5,534 | 0,256 | 1,744 |
| 12 | 0,866 | 0,925 | 0,266 | 3,258 | 0,924 | 5,592 | 0,284 | 1,716 |
| 13 | 0,832 | 0,884 | 0,249 | 3,336 | 1,026 | 5,646 | 0,308 | 1,692 |
| 14 | 0,802 | 0,848 | 0,235 | 3,407 | 1,121 | 5,693 | 0,329 | 1,671 |
| 15 | 0,775 | 0,816 | 0,223 | 3,472 | 1,207 | 5,737 | 0,348 | 1,652 |
| 16 | | 0,788 | 0,212 | 3,532 | | | 0,364 | 1,636 |
| 17 | | 0,762 | 0,203 | 3,588 | | | 0,379 | 1,621 |
| 18 | | 0,738 | 0,194 | 3,640 | | | 0,392 | 1,608 |
| 19 | | 0,717 | 0,187 | 3,689 | | | 0,404 | 1,596 |
| 20 | | 0,697 | 0,180 | 3,735 | | | 0,414 | 1,586 |
| 21 | | 0,679 | 0,173 | 3,778 | | | 0,425 | 1,575 |
| 22 | | 0,662 | 0,167 | 3,819 | | | 0,434 | 1,566 |
| 23 | | 0,647 | 0,162 | 3,858 | | | 0,443 | 1,557 |
| 24 | | 0,632 | 0,157 | 3,895 | | | 0,452 | 1,548 |
| 25 | | 0,619 | 0,153 | 3,931 | | | 0,459 | 1,541 |