# Shaft Selection

Refer to Selection Charts 1 and 2 developed by the American Society of Mechanical Engineers to simplify selection. Use the charts in conjunction with the Service Factors shown in Table 1 to modify the selection for conditions under which the shaft will operate.

Important factors to consider when calculating shaft size:

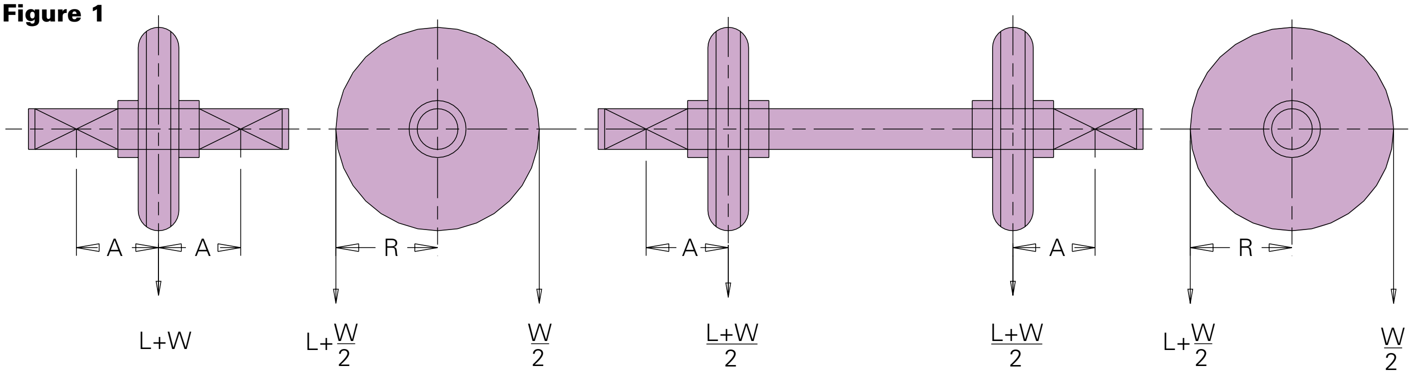
a. The shaft is subject to a bending moment and a torsional moment.

b. A bending moment is that force which tends to bend a shaft.

c. Torsional moment is that force which tends to twist a shaft.

d. Shaft size is determined by the combined action of the bending and the torsional moments.

**Figure 1**




L = Total unbalanced load in pounds.
W = Total suspended weight of elevator (chain, buckets, etc.,) pounds.
R = Radius of wheel in inches.

B = Bending moment.
T = Torsional moment.

$B = A \frac{L+W}{2}$ inch pounds.

$T = R \times L$ inch pounds.

## Selection Procedure

1. Compute the bending moment from the formula shown in Figure 1.
2. Determine the service factor for the bending that will suit conditions from Table 1.
3. Compute the torsional moment from the formula, shown in Figure 1.
4. Determine the service factor for torsion that will suit conditions from Table 1.
5. Draw a vertical line across Selection Chart 1 or 2 from the point where the bending moment intersects its selected service factor line.
6. Draw a horizontal line up Selection Chart 1 or 2 from the point where the bending moment intersects its selected service factor line.
7. The intersection of above lines will give required shaft size.
8. For shafts not weakened by keyways, multiply the shaft size obtained by 0.91 for the corrected shaft size. See note embedded in Selection Chart 2.

Horsepower may be computed directly from the right-hand side of Selection Charts by correcting the figure in line with the horizontal torsional moment line by the speed in RPM.

**Table 1 — Service Factors**

| Service Factors | For Bending | For Torsion |
|---|---|---|
| **Stationary Shafts**<br>Gradually applied loads<br>Suddenly applied loads | <br>1.0<br>1.5 - 2.0 | <br>1.0<br>1.5 - 2.0 |
| **Rotating Shafts**<br>Gradually applied or steady loads | <br>1.5 | <br>1.0 |
| **Suddenly Applied Loads**<br>Minor shock only | <br>1.5 - 2.0 | <br>1.0 - 1.5 |
| **Suddenly Applied Loads**<br>Heavy shocks | <br>2.0 - 2.5 | <br>1.5 - 2.5 |

## Chart 1 — Quick Selection

Note: All shaft size selections shown are based on the ASME code, ASA-BITC. This standard is not favored for most applications. A new code, ANSI B106, supersedes ASA-BITC. ANSI-B106 is based on fatigue theory which accounts for combined stresses due to reverse.

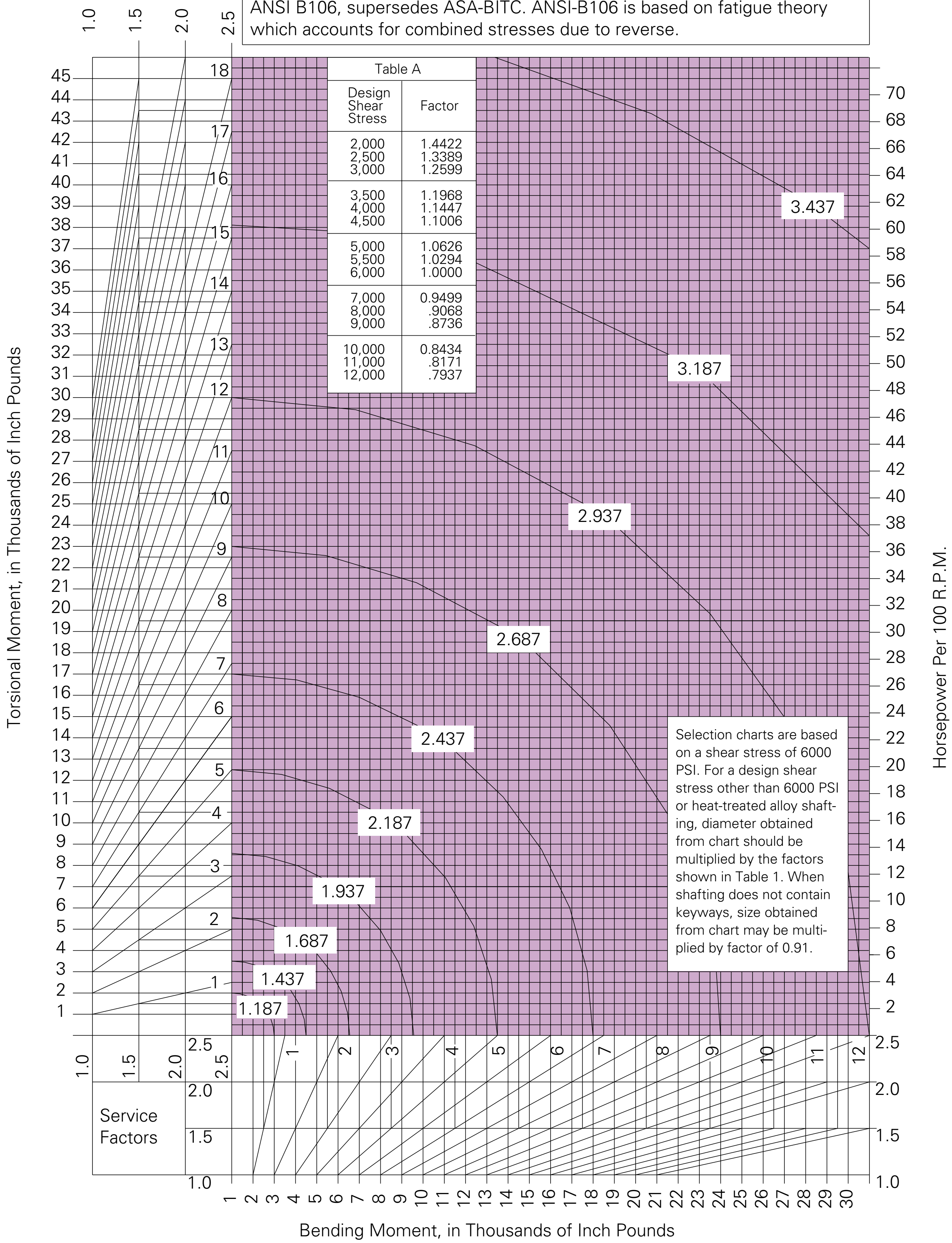


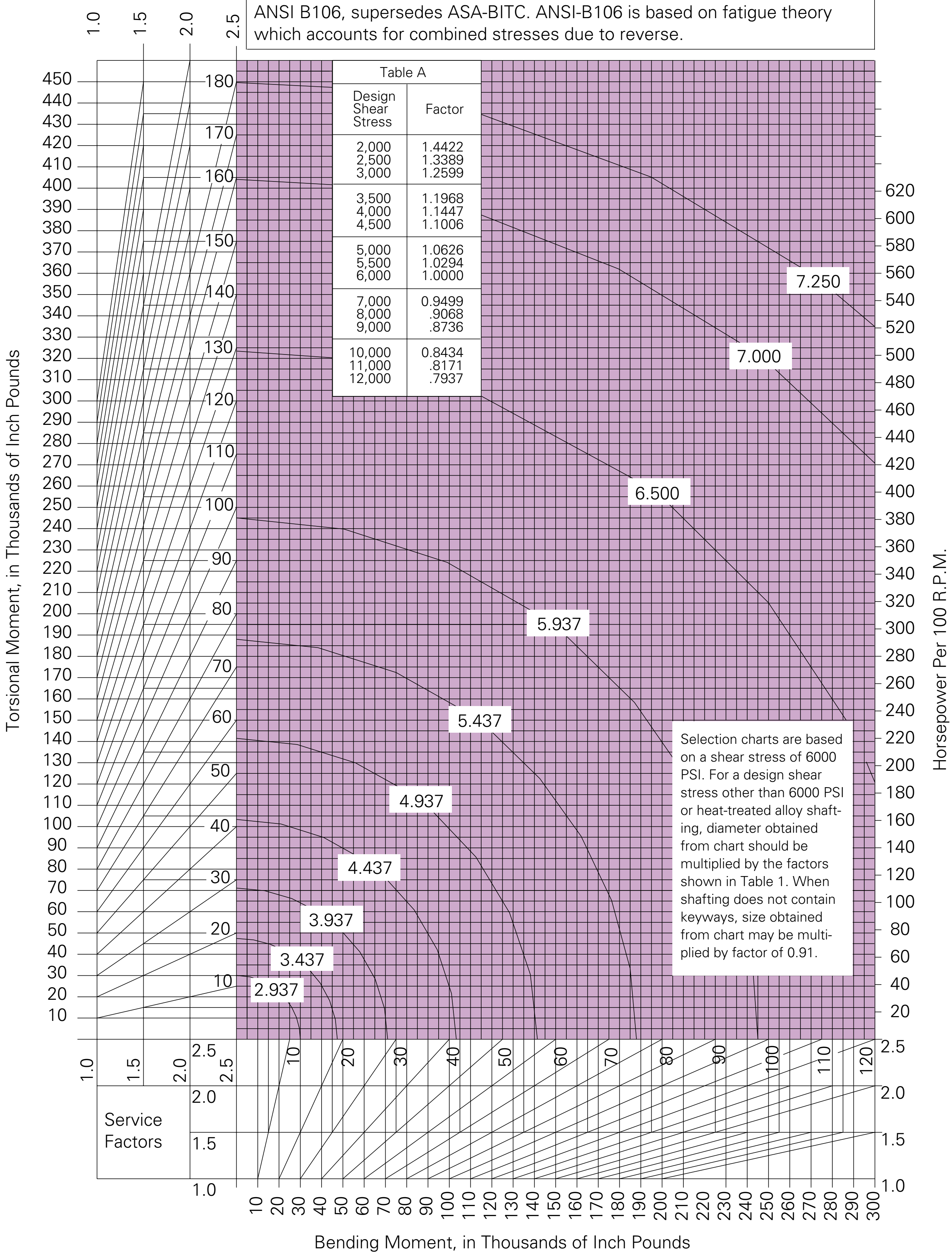

Table A

| Design Shear Stress | Factor |
|---|---|
| 2,000 | 1.4422 |
| 2,500 | 1.3389 |
| 3,000 | 1.2599 |
| 3,500 | 1.1968 |
| 4,000 | 1.1447 |
| 4,500 | 1.1006 |
| 5,000 | 1.0626 |
| 5,500 | 1.0294 |
| 6,000 | 1.0000 |
| 7,000 | 0.9499 |
| 8,000 | .9068 |
| 9,000 | .8736 |
| 10,000 | 0.8434 |
| 11,000 | .8171 |
| 12,000 | .7937 |

Selection charts are based on a shear stress of 6000 PSI. For a design shear stress other than 6000 PSI or heat-treated alloy shafting, diameter obtained from chart should be multiplied by the factors shown in Table 1. When shafting does not contain keyways, size obtained from chart may be multiplied by factor of 0.91.

## Chart 2 — Shaft Selection

Note: All shaft size selections shown are based on the ASME code, ASA-BITC. This standard is not favored for most applications. A new code, ANSI B106, supersedes ASA-BITC. ANSI-B106 is based on fatigue theory which accounts for combined stresses due to reverse.

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## Helpful Formulas

### Horsepower

Horsepower equals 33,000 foot pounds per minute, or 550 foot pounds per second. In terms of chain load and speed

$$HP = \frac{\text{Working Load x Ft. per Min.}}{33{,}000}$$

$$\text{or } HP = \frac{\text{Working Load x T x P x R.P.M.}}{396{,}000}$$

Where:
T = Number of sprocket teeth
P = Chain pitch

### Chain Rolling Friction

$$f_r = f_s \frac{d}{D}$$

Where:
$f_r$ = Coefficient of rolling friction
$f_s$ = Coefficient of sliding friction
d = Bushing outside diameter
D = Roller outside diameter

### Chain Working Load

When the horsepower input is known and the chain working load is desired, this can be calculated as follows:

$$\text{Working Load} = \frac{\text{HP x 33,000}}{\text{Ft. per Min.}}$$

$$\text{or Working Load} = \frac{\text{HP x 396,000}}{\text{T x P x R.P.M.}}$$

### Factor of Safety

Factor of Safety is determined as follows:

$$\text{F.S.} = \frac{\text{Chain Average Ultimate Strength}}{\text{Chain Working Load}}$$

### Chain Speed

Chain Speed can be determined from the following formula:

$$\text{Chain Speed (ft. per min.)} = \frac{\text{T x R.P.M.}}{K}$$

Where:
T = Number of sprocket teeth
K = Pitches of chain per foot

### Chain Bearing Pressure

Chain Bearing Pressure can be figured as follows:

$$\text{Bearing Pressure (lbs. per sq. in.)} = \frac{\text{Working Load}}{\text{L x D}}$$

Where:
L = Bushing length
D = Pin diameter

### Torque in Inch Pounds

Torque in Inch Pounds is converted into HP by:

$$\frac{\text{Torque x R.P.M.}}{63{,}000} = \text{Horsepower}$$

### Torque in Foot Pounds

Torque in Foot Pounds is converted into HP by:

$$\frac{\text{Torque x R.P.M.}}{5{,}250} = \text{Horsepower}$$

### Kilowatts to HP

To convert Kilowatts to HP:

1 K.W. = 1 1/2 HP (approx.)

$$HP = \frac{\text{K.W.}}{\text{.746 x Efficiency}}$$

Efficiency = .9 for generators
Efficiency = .87 for motors (3 phase)

### Chain Lengths in Pitches (Approx.)

$$\text{Chain Length} = \frac{S}{2} + 2C + \frac{.0253\,D^2}{C}$$

Where:
S = Sum of teeth, both sprockets
C = Center distance in pitches
D = Difference in number of teeth both sprockets