This manual contains engineering specifications and application data for the tube style top running rotating axle end trucks.

To properly select and apply the correct end trucks, a series of engineering calculations as contained in the application data sections of this manual must be completed by a competent person. Should there be questions concerning the use of this manual, or doubt that your calculations have been properly completed, please contact the Engineering Department at Lift-Tech International, 800-866-6696.
Parts of this specification refer to portions of the Crane Manufacturers Association of America (CMAA) specifications. Send requests to obtain copies of the CMAA specifications for single and double girder cranes to the following address.

Crane Manufacturers Association of America, Inc.
8720 Red Oak Blvd., Suite 201
Charlotte, North Carolina 28217-3992

<table>
<thead>
<tr>
<th>Wheel Dia.</th>
<th>*Wheel Base</th>
<th>**Weight per Pair</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>7’-6”</td>
<td>1224#</td>
<td>* Wheel bases available from 3’-6” thru 14’-6” for 12, 15, &amp; 18” end trucks, and 3’-6” thru 10’-0” for 9” end trucks, upon request. ** Approximate Weight per pair of end trucks does not include the drive component weights: (Motor, Brake, Gearbox)</td>
</tr>
<tr>
<td></td>
<td>8’-0”</td>
<td>1273#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8’-6”</td>
<td>1322#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9’-0”</td>
<td>1371#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9’-6”</td>
<td>1420#</td>
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<tr>
<td></td>
<td>10’-0”</td>
<td>1469#</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>9’-0”</td>
<td>2238#</td>
<td>Refer to Structural Tube Rotating Axle End Trucks Parts List manual for exploded end truck assembly drawing and detailed repair parts list.</td>
</tr>
<tr>
<td></td>
<td>10’-0”</td>
<td>2360#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10’-6”</td>
<td>2421#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11’-0”</td>
<td>2482#</td>
<td>Bumper Lengths and OSHA requirements are covered on pages 12-14.</td>
</tr>
<tr>
<td></td>
<td>11’-6”</td>
<td>2543#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12’-0”</td>
<td>2604#</td>
<td>Bearing Lubrication Specifications shown on page 14.</td>
</tr>
<tr>
<td>15</td>
<td>10’-0”</td>
<td>3450#</td>
<td>Refer to page 15 for end truck outline dimensions, these dimensions are not certified engineering dimensions and are to be used for estimating purposes only, contact factory for certified engineering end truck dimensions.</td>
</tr>
<tr>
<td></td>
<td>10’-6”</td>
<td>3525#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11’-0”</td>
<td>3600#</td>
<td></td>
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<td></td>
<td>11’-6”</td>
<td>3675#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12’-0”</td>
<td>3750#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12’-6”</td>
<td>3825#</td>
<td>Standard 12, 15 and 18” End Trucks come with wheels and rail sweeps for 55# - 105# rail. Wheels and rail sweeps available for 30# - 55# rail.</td>
</tr>
<tr>
<td>18</td>
<td>10’-0”</td>
<td>5050#</td>
<td>Standard 9” End Trucks come with wheels and rail sweeps for 40# - 60# rail. Wheels and rail sweeps available for 20# - 30# rail.</td>
</tr>
<tr>
<td></td>
<td>10’-6”</td>
<td>5152#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11’-0”</td>
<td>5254#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11’-6”</td>
<td>5356#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12’-0”</td>
<td>5458#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12’-6”</td>
<td>5560#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13’-0”</td>
<td>5662#</td>
<td></td>
</tr>
</tbody>
</table>

** SPECIFICATIONS **

Truck Designed for Indoor Service.
Truck Structure is Symmetrically Designed.
Trucks are Fabricated from Structural Steel Tube.
Wheel Bearings are Self-Aligning Spherical Roller Type, Equally Spaced on Both Sides of Wheel.
Bearings Individually Lubricated Through Standard Grease Fittings.
Labyrinth Type Bearing Seals.
Cast Iron Bearing Cartridges.
Wheels are Steel with Treads Hardened to 400 - 450 BHN.
Standard Wheels are Straight Tread, Taper Tread Wheels are available.
Axles are Machined from Heat Treated Alloy Steel.
Driver Wheels are Held to Axle by Interference Fit and Key.
Trailer Wheels are Held to Axle by Interference Fit only.

*NOTE: Information given in this manual is subject to change without notice.*

Page 2
**ACTUAL** Wheel Load at $P_A$:

$$P_A = \left( \frac{R_1 \times c}{WB} \right) + \frac{R_T}{2}$$

**ACTUAL** Wheel Load at $P_B$:

$$P_B = \left( \frac{R_1 \times d}{WB} \right) + \frac{R_T}{2}$$

Where:

- $R_1 = R_{1DLT} + R_{1LLT} + R_{1DLB}$
- $R_{1DLT} = $ Trolley dead load reaction (lbs)
- $R_{1LLT} = $ Trolley live load reaction (lbs)
- $R_{1DLB} = $ Dead load of bridge reaction (lbs)
- $R_T = $ End truck dead weight (lbs)

* Position trolley adjacent to end truck for reaction calculations.

### Trolley Dead Load Bending Moment:

$$P_{A_{DLT}} = \left( \frac{R_{1DLT} \times c}{WB} \right)$$

$$BM_{ADLT} = (P_{ADLT})(d)$$

$$P_{B_{DLT}} = \left( \frac{R_{1DLT} \times d}{WB} \right)$$

$$BM_{BDLT} = (P_{BDLT})(c)$$

### Trolley Live Load Bending Moment:

$$P_{A_{LLT}} = \left( \frac{R_{1LLT} \times c}{WB} \right)$$

$$BM_{ALLT} = (P_{ALLT})(d)$$

$$P_{B_{LLT}} = \left( \frac{R_{1LLT} \times d}{WB} \right)$$

$$BM_{BLLT} = (P_{BLLT})(c)$$

### End Truck Dead Load Bending Moment:

$$BM_{AET} = \left( \frac{R_T \times d}{2 \times WB} \right) \times c$$

$$BM_{BET} = \left( \frac{R_T \times c}{2 \times WB} \right) \times d$$

### Bridge Dead Load Bending Moment:

$$P_{A_{DLB}} = \left( \frac{R_{1DLB} \times c}{WB} \right)$$

$$BM_{ADLB} = (P_{ADLB})(d)$$

$$P_{B_{DLB}} = \left( \frac{R_{1DLB} \times d}{WB} \right)$$

$$BM_{BDLB} = (P_{BDLB})(c)$$

$$BM_A = BM_{ADLT} + BM_{ALLT} + BM_{ADLB} + BM_{AET}$$

$$BM_B = BM_{BDLT} + BM_{BLLT} + BM_{BDLB} + BM_{BET}$$

* Use $BM_A$ or $BM_B$, whichever is largest, to apply vertical inertia factors $HLF$ and $DLF$.

### Vertical Bending Moment:

$$DLF = 1.1 \leq 1.05 + \frac{Travel\ Speed\ (FPM)}{2000} \leq 1.2$$

$$HLF = 1.15 \leq 1 + (0.005 \times Hoist\ Speed\ (FPM)) \leq 1.5$$

Calculate the vertical bending moment using the summation values for $BM_A$ or $BM_B$, whichever is largest.

$$BM_V = (BM_{DLT} \times DLF) + (BM_{LLT} \times HLF) + (BM_{DLB} \times DLF) + (BM_{ET} \times DLF)$$

The total vertical bending moment including vertical inertia factors, $BM_V$, must be compared with the chart on page 4.

※ Taken from CMAA specification #70 and #74, revised 2000.
If \( \text{ACTUAL} \) calculated wheel load is larger than the \( \text{DURABILITY} \) wheel load in the above chart, the \( \text{ACTUAL} \) wheel load must be converted to an Equivalent Durability wheel load. See page 8 and 9.

Example:
Assume a Wheel/Truck Selection is required for a load \( R_1 \) of 35,500#, with a wheel base of 10'-0" and a dimension \( d \) of 40" to run on 40# rail at 100 FPM bridge travel speed and 30 FPM hoist lifting speed.

**Required Information:**

\[
\begin{align*}
R_{1\text{DLT}} &= 3500 \# \\
R_{1\text{LLT}} &= 17000 \# \\
R_{1\text{DLB}} &= 15000 \# \\
R_1 &= 35500 \# \\
**Assumed** R_T &= 1180 \# (12" end truck) \\
\text{Runway Rail} &= 40 \#/\text{yd}
\end{align*}
\]

**Solution:**

**ACTUAL** Wheel Load at \( P_A \) = 24257 #

**ACTUAL** Wheel Load at \( P_B \) = 12423 #

\[
\begin{align*}
P_{\text{ADLT}} &= 2333 \# \\
P_{\text{BDLT}} &= 1167 \# \\
P_{\text{ALLT}} &= 11333 \# \\
P_{\text{BLLT}} &= 5667 \# \\
P_{\text{ADLB}} &= 10000 \# \\
P_{\text{BDLB}} &= 5000 \#
\end{align*}
\]

**Vertical Bending Moment:**

\[
\begin{align*}
BM_{\text{DLT}} &= 93333 \times \text{DLF} \\
BM_{\text{LLT}} &= 453333 \times \text{HLF} \\
BM_{\text{DLB}} &= 400000 \times \text{DLF} \\
BM_{\text{ET}} &= 15733 \times \text{DLF}
\end{align*}
\]

**Selection:** Select an end truck from wheel load/bending moment chart above with an allowable wheel load of 24,257# or more and an allowable bending moment of 1,081,307 in-# or more for the runway rail size being used. **15" Truck Selected**

**Suggestion:** By increasing \( d \) up to a maximum of \((\text{WB}/2)\) the maximum wheel load at \( A \) is reduced. By increasing \( d \) to 60" a 12" end truck could be used.

**An initial assumption regarding the truck weight must be made to begin the calculation. In this example the weight of (1) 12" end truck was assumed, however, the results require that a 15" end truck be used. Therefore, the results must be re-evaluated using the required 15" truck weight.**
Where:

$R_1 = R_{1DLT} + R_{1LLT} + R_{1DLB}$

$R_2 = R_{2DLT} + R_{2LLT} + R_{2DLB}$

$R_{1DLT} =$ Trolley dead load reaction at drive girder (lbs)

$R_{2DLT} =$ Trolley dead load reaction at idler girder (lbs)

$R_{1LLT} =$ Trolley live load reaction at drive girder (lbs)

$R_{2LLT} =$ Trolley live load reaction at idler girder (lbs)

$R_{1DLB} =$ Dead load reaction at drive girder (lbs)

$R_{2DLB} =$ Dead load reaction at idler girder (lbs)

$R_T =$ End truck dead weight (lbs)

* Position trolley adjacent to end truck for reaction calculations.

Trolley Dead Load Bending Moment:

$$P_{A_{DLT}} = \left( \frac{R_{1DLT} \times c}{WB} \right) + \left( \frac{R_{2DLT} \times e}{WB} \right)$$

$BM_{ADLT} = (P_{ADLT})(d)$

$$P_{B_{DLT}} = \left( \frac{R_{1DLT} \times d}{WB} \right) + \left( \frac{R_{2DLT} \times f}{WB} \right)$$

$BM_{BDLT} = (P_{BDLT})(e)$

End Truck Dead Load Bending Moment:

$$BM_{AET} = \left( \frac{R_T \times d}{2 \times WB} \right) \times c$$

Bridge Dead Load Bending Moment:

$$P_{A_{DLB}} = \left( \frac{R_{1DLB} \times c}{WB} \right) + \left( \frac{R_{2DLB} \times e}{WB} \right)$$

$BM_{ADLB} = (P_{ADLB})(d)$

$$P_{B_{DLB}} = \left( \frac{R_{1DLB} \times d}{WB} \right) + \left( \frac{R_{2DLB} \times f}{WB} \right)$$

$BM_{BDLB} = (P_{BDLB})(e)$

$$BM_A = BM_{ADLT} + BM_{ADLB} + BM_{ADLB} + BM_{AET}$$

$$BM_B = BM_{BDLT} + BM_{BLBT} + BM_{BDLB} + BM_{BET}$$

**VERTICAL BENDING MOMENT:**

$$\Phi \; DLF = 1.1 \leq 1.05 + \frac{TravelSpeed(FPM)}{2000} \leq 1.2$$

$$HLF = 1.15 \leq 1 + (0.005 \times HoistSpeed(FPM)) \leq 1.5$$

Calculate the vertical bending moment using the summation values for $BM_A$ or $BM_B$, whichever is largest.

$BM_v = (BM_{DLT} \times DLF)+ (BM_{LLT} \times HLF)+ (BM_{DLB} \times DLF)+ (BM_{ET} \times DLF)$

The total vertical bending moment including vertical inertia factors, $BM_v$, must be compared with the chart on page 6.

$\Phi$ Taken from CMAA specification #70 and #74, revised 2000.
**Rotating Axle End Trucks**

### Two Concentrated Loads

<table>
<thead>
<tr>
<th>Wheel Diameter</th>
<th>Allowable Equivalent Durability Wheel Load (P<strong>e</strong> Allowable) (pounds)</th>
<th>Maximum Allowable Bending Moment (inch-pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASCE 20#</td>
<td>ASCE 40#</td>
</tr>
<tr>
<td>9</td>
<td>11,300</td>
<td>16,800</td>
</tr>
<tr>
<td>12</td>
<td>22,400</td>
<td>31,400</td>
</tr>
<tr>
<td>15</td>
<td>28,000</td>
<td>39,300</td>
</tr>
<tr>
<td>18</td>
<td>33,700</td>
<td>47,200</td>
</tr>
<tr>
<td>Effective Rail Head Width (inch)</td>
<td>0.844</td>
<td>1.250</td>
</tr>
</tbody>
</table>

* These are the Maximum Allowable Equivalent Durability Wheel Loads, **DO NOT EXCEED**

If **Actual** calculated wheel load is larger than the DURABILITY wheel load in the above chart, the **Actual** wheel load **must be** converted to and Equivalent Durability Wheel Load. See page 8 and 9.

**Example:** Assume a Wheel/Truck selection is required for a drive girder load (**R**1) of 27,000# and idler girder load (**R**2) of 15,000#, with a wheelbase of 10'-0" and a dimension **d** of 20", dimension **e** of 28" to run on 40# runway rail.

at 100 FPM bridge travel speed and 30 FPM hoist lifting speed.

**Required Information:**

| **R**1DLT | 1200 # |
| **R**1LLT | 20000 # |
| **R**1DLB | 5800 # |
| **R**1 | 27000 # |
| **R**2DLT | 1200 # |
| **R**2LLT | 8000 # |
| **R**2DLB | 5800 # |
| **R**2 | 15000 # |

**Assumed** **R**1 = 1180 # (12" end truck)

Runway Rail = 40 #/yd

**Solution:**

**Actual** Wheel Load at **P**A = 26590 #

**Actual** Wheel Load at **P**B = 16590 #

**P**ADLT = 1280 #

**P**BDLT = 1120 #

**P**ALLT = 18533 #

**P**BLLT = 9467 #

**P**ADLB = 6187 #

**P**BDLB = 5413 #

**Vertical Bending Moment:**

| **BM**DLT | 25600 x DLF 1.10 = 28160 in-# |
| **BM**LLT | 370667 x HLF 1.15 = 426267 in-# |
| **BM**DLB | 123733 x DLF 1.10 = 136107 in-# |
| **BM**ET | 9833 x DLF 1.10 = 10817 in-# |

**BM**V = 601350 in-#

**Selection:** Select an end truck from "Truck Properties" chart with an allowable wheel load of 26,590# or more and an allowable bending moment of 601,350 in-# or more. **Select a 15" End Truck.**

**An initial assumption regarding the truck weight must be made to begin the calculation. In this example the weight of (1) 12" end truck was assumed, however, the results require that a 15" end truck be used. Therefore, the results must be re-evaluated using the required 15" truck weight.**
ACTUAL Wheel Load at $P_A$:

$$P_A = \frac{R_U \times WB}{2} + \frac{R_T}{2}$$

ACTUAL Wheel Load at $P_B$:

$$P_B = \frac{R_U \times WB}{2} + \frac{R_T}{2}$$

Where:

- $R_U =$ Uniform Dead Load (lbs/in)
- $R_T =$ End Truck Dead Weight (lbs)
- $WB =$ End Truck Wheelbase (in)

Uniform Dead Load Bending Moment:

$$BM_A = BM_B = \left( \frac{R_U \times (WB^2)}{8} \right) + \left( \frac{R_T \times WB}{8} \right)$$

$\delta$ $DLF = 1.1 \leq 1.05 + \frac{Travel\ Speed(FPM)}{2000} \leq 1.2$

$\delta$ Taken from CMAA specification #70 and #74, revised 2000.

VERTICAL BENDING MOMENT:

Since $BM_A = BM_B$ either one can be used for the bending moment calculation.

$BM_v = BM \times DLF$

The total vertical bending moment including vertical inertia factors, $BM_v$, must be compared with the chart on page 7.

### ROTATING AXLE END TRUCKS

#### UNIFORM LOADING EXAMPLE CALCULATION

<table>
<thead>
<tr>
<th>Wheel Diameter</th>
<th>Allowable Equivalent Durability Wheel Load ($P_e$ Allowable) (pounds)</th>
<th>Maximum Allowable Bending Moment (inch-pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASCE 20#</td>
<td>ASCE 40#</td>
</tr>
<tr>
<td>9</td>
<td>11,300</td>
<td>16,800</td>
</tr>
<tr>
<td>12</td>
<td>22,400</td>
<td>31,400</td>
</tr>
<tr>
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<td>39,300</td>
</tr>
<tr>
<td>18</td>
<td>33,700</td>
<td>47,200</td>
</tr>
<tr>
<td>Effective Rail Head Width (inch)</td>
<td>0.844</td>
<td>1.250</td>
</tr>
</tbody>
</table>

* These are the Maximum Allowable Equivalent Durability Wheel Loads, **DO NOT EXCEED**

Example: Assume a Wheel/Truck Selection is required for a uniform load ($R_U$) of 9600 #/ft with a wheel base of 10'-0" to run on ASCE 80# runway rail, traveling 200 FPM.

Required Information:

- $R_U =$ 9600 #/ft
- $WB =$ 120 in.
- $R_T =$ 1725 # (15" end truck)
- $DLF =$ 1.15

Solution:

- $ACTUAL$ Wheel Load at $P_A =$ 48863 #
- $ACTUAL$ Wheel Load at $P_B =$ 48863 #

$$BM_A = BM_B = 1465875 \times DLF \times 1.15 = 1685756 \text{ in-#}$$

Selection: Select an end truck from "Truck Properties" chart with an allowable wheel load of 48,863# or more and an allowable bending moment of 1,685,756 in-# or more. **Select an 18" Truck**

**An initial assumption regarding the truck weight must be made to begin the calculation. In this example the weight of (1) 15" end truck was assumed, however, the results require that a 18" end truck be used. Therefore, the results must be re-evaluated using the required 18" truck weight.**
\[ P_e = P_{\text{MAX}} \times K_{WL} \]

\[ K_{WL} = K_{BW} \times C_S \times S_M \]

\[ K_{BW} = \text{Bridge Wheel Load Factor} \]

\[ C_S = \text{Speed Factor} \]

\[ S_M = \text{Wheel Service Factor} \]

**Speed Factor Equation:**

\[ RPM = \frac{V_B \times 12}{\pi \times d} \]

\[ RPM \leq 31.5 \Rightarrow C_S = 1 + \left( \frac{RPM - 31.5}{360} \right)^2 \]

\[ RPM > 31.5 \Rightarrow C_S = 1 + \left( \frac{RPM - 31.5}{328.5} \right) \]

**Bridge Wheel Load Factor Equation:**

\[ K_{BW} = \frac{0.75BW + F(LL) + 0.5(TW) - 0.5FTW}{0.75BW + 1.5F(LL)} \]

Where:

- \( RPM \): Wheel Speed of Rotation
- \( V_B \): Bridge Speed (FPM)
- \( d \): End Truck Wheel Diameter
- \( BW \): Bridge Dead Weight
- \( TW \): Trolley Dead Weight
- \( LL \): Trolley Dead Weight + Live Load
- \( F = 1-(HA/Span) \)
- \( HA \): Minimum Hook Approach to Runway Rail
- \( Span \): Crane Span

<table>
<thead>
<tr>
<th>CLASS OF CRANE SERVICE</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>*K_{WL} min.</td>
<td>0.80</td>
<td>0.85</td>
</tr>
<tr>
<td>( S_M )</td>
<td>1.00</td>
<td>1.12</td>
</tr>
</tbody>
</table>

* If calculated \( K_{WL} \) factor is less than \( K_{WL} \) min. from chart, use \( K_{WL} \) min. factor.

The **ACTUAL** wheel load calculated must first be compared with the allowable equivalent durability wheel load chart, if the **ACTUAL** wheel load is less than the charted value, then it is not necessary to convert the **ACTUAL** wheel load to an equivalent durability wheel load.

* Taken from CMAA specification #70 and #74, revised 2000. Excerpt of **class of crane service** chart shown.
The above chart contains EQUIVALENT DURABILITY WHEEL LOADS, if the actual calculated wheel load is less than the charted value you do not need to calculate the equivalent durability wheel load.

Example: Convert the ACTUAL wheel load given into an Equivalent Durability Wheel Load using the given data. This example illustrates an application where the ACTUAL wheel load exceeds the allowable equivalent durability wheel load value in the above chart for the specified rail size.

**Required Information:**

| Actual Wheel Load, \( P_{\text{max}} \) | 24000 | # |
| d | 12 | in. |
| \( V_B \) | 200 | FPM |
| BW | 10000 | # |
| TW | 2000 | # |
| \( LL \) | 20000 | # |
| HA | 36 | in. |
| Span | 720 | in. |
| Runway Rail Size | 40 | #/yd |

**Solution:**

\[
F = 0.95 \\
K_{BW} = 0.738 \\
\text{RPM} = 63.7 \quad \text{Bridge Wheel Speed of Rotation} \\
C_S = 1.098 \\
S_M = 1.00 \quad \text{For Class C Service} \\
K_{WL \ (\text{min})} = 0.80 \\
K_{WL} = 0.810 \quad \text{If } K_{WL} \text{ is less than } K_{WL \ (\text{min})} \text{ use } K_{WL \ (\text{min})} \text{ otherwise use } K_{WL}. \\
Pe = 19433 \# \quad \text{ACCEPTABLE}
\]

**Conclusion:**
The Equivalent Durability Wheel Load (Pe) calculated above is less than the charted allowable equivalent durability wheel load for the specified rail size, therefore, the wheel load is no longer the limiting factor in the end truck selection process.
ROTATING AXLE END TRUCKS

APPLICATION DATA FOR REQUIRED MOTOR HORSEPOWER

Total Driven Load:

\[ W_B = \text{Total Bridge Weight (Girders, Footwalks, End Trucks, Bridge Mounted Controls, Drives, etc.) (lbs.)} \]
\[ W_T = \text{Hoist and Trolley Weight (lbs.)} \]
\[ \text{LL} = \text{Live Load and Below the Hook Lifting Devices (lbs.)} \]
\[ W = \text{Total Driven Load} = \frac{(W_B + W_T + \text{LL})}{2000} \text{ (tons)} \]

Required Horsepower Equation:

\[ HP = K_A \times W \times V \times K_s \]

Where:

\( K_A \) = Acceleration Factor for type of motor used
\( W \) = Total Driven Load (in tons) including all live and dead loads
\( V \) = Rated Drive Speed (FPM)
\( K_s \) = Service Factor which accounts for type of drive and duty cycle (see table 1)

Acceleration Factor Equation:

\[ K_A = \frac{f + \left( \frac{2000a \times C_r}{g \times E} \right) \times N_f}{33,000 \times N_f} \]

For AC Motors \( \frac{N_r}{N_t} \) can be assumed 1

Where:

\( f \) = Rolling Friction of Drive (including transmission losses)(lbs/ton) (see table 2)
\( a \) = Average or Equivalent Uniform Acceleration Rate up to rated motor RPM (see table 4 and 3)
\( C_r \) = Rotational Inertia Factor

\[ C_r = 1.05 + \left( \frac{a}{7.5} \right) \]

\( g \) = Gravitational Constant 32.2 (ft/sec²)
\( E \) = Mechanical Efficiency of Drive Machinery (assume .95 mechanical efficiency for individual drive)
\( N_r \) = Rated Speed of Motor at Full Load (RPM)
\( N_f \) = Free Running RPM of motor when driving at speed \( V \)
\( K_t \) = Equivalent Steady State Torque relative to rated motor Torque = 1.30

For Individual Drive Cranes the required horsepower is 2/3 of the total on EACH end truck drive.

### Table 1 Drive Service Factor (\( K_s \))

<table>
<thead>
<tr>
<th>CMAA Service Class</th>
<th>AC Inverter</th>
<th>AC Magnetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustable Voltage w/DC Shunt Motors</td>
<td>( C )</td>
<td>1.0</td>
</tr>
<tr>
<td>( D )</td>
<td>1.1</td>
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</tr>
</tbody>
</table>

### Table 2 Friction Factor (\( f \)) metallic wheels & anti-friction bearings

<table>
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<tr>
<th>Wheel Dia inches</th>
<th>18</th>
<th>15</th>
<th>12</th>
<th>10</th>
<th>8</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction lbs/ton</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

Use for 9” Wheel

*\( \star \) Taken from CMAA specification #70 and #74, revised 2000. Excerpts of drive service factor and friction factor charts shown.*
Example: Appropriately size the required individual drive motor horsepower for the given AC application: 10 Ton capacity 60’ span single girder crane on 10'-0” wheelbase 15” end trucks at a bridge speed of 120 FPM.

Required Information:

<table>
<thead>
<tr>
<th>Bridge Girder Weight</th>
<th>14000  #</th>
<th>f (rolling friction factor) = 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Selected End Trucks</td>
<td>3450  #</td>
<td>a (acceleration factor) = 0.35</td>
</tr>
<tr>
<td>Estimated Drive Weight</td>
<td>1300  #</td>
<td>Cr (rotational inertia factor) = 1.10</td>
</tr>
<tr>
<td>Weight of Hoist/Trolley</td>
<td>1500  #</td>
<td>g (gravitational constant) = 32.2</td>
</tr>
<tr>
<td>Total Crane Dead Weight</td>
<td>20250  #</td>
<td>E (mechanical efficiency) = 0.95</td>
</tr>
<tr>
<td>Total Live Load</td>
<td>20000  #</td>
<td>V (rated drive speed) = 120</td>
</tr>
<tr>
<td>Total Driven Load</td>
<td>40250  #</td>
<td>Kt (accelerating torque factor) = 1.30</td>
</tr>
<tr>
<td>Driven Load (Total Driven Load/20000) (W)</td>
<td>20.125 Tons</td>
<td>Ks (Service Factor) = 1.00</td>
</tr>
</tbody>
</table>

Solution:

\[ Ka = 0.0009346 \]

For Individual Drive Configurations use 2/3 of Total Horsepower for EACH End Truck Drive = 1.50

Conclusion: Since this is an individual drive application, the motor requirement is (2) 1 1/2 horsepower motors.
When determining the size of bumper for a crane, trolley, or hoist or other moving equipment, the magnitude of the energy to be stopped, expressed in foot-pounds (ft-lbs) must be established. This energy is a function of the weight of the equipment and the travel speed at which impact occurs. The second consideration is the rate of deceleration, expressed in (ft/sec²). OSHA (spec. 1910/179), CMAA(spec 70, as amended) and other agencies have established MINIMUM guidelines for the decelerating and stopping of cranes.

FOR THE CRANE BRIDGE: OSHA
The bumpers, usually two, must be large enough to absorb the impact energy (ft-lbs) at 40% of full speed. Deceleration must not exceed 3.0 ft/sec² at 20% of full speed.

You may decide that this minimum protection is not sufficient for your equipment and substitute CMAA or your own higher speed values. The following steps to determine bumper size in conjunction with your energy absorption, deflection, and maximum force curves will allow you to calculate bumper size.

The final force curve will show you the load imposed upon your structure to which the bumper is mounted.

**ENERGY CALCULATION FOR BRIDGE: OSHA**

- **S** = Traveling bridge span in feet.
- **D** = Load to support distance in feet.
- **VB** = Maximum traveling bridge speed ft/min.
- **WB** = Bridge only weight.
- **WT** = Trolley & Hoist only weight.

**DETERMINATION OF TRAVELING BRIDGE BUMPER SIZE: OSHA**

1) Determine the traveling bridge weight less load (WB), and trolley weight (WT) in pounds. From manufacturers specifications.
2) With the trolley against its stops at the end of the traveling bridge, determine the minimum distance (D) in feet from the center of gravity of trolley to the centers of the traveling bridge bumpers. Use manufacturers specifications if available.
3) Determine the distance (S) in feet between the traveling bridge bumpers.
4) Determine the traveling bridge maximum speed (VB) in ft/min from manufacturers specifications.
5) Determine the traveling bridge energy (BE) at impact at 40% of full speed by using:

\[
BE_{40\%} = \left( \frac{0.4 \times VB}{231840} \right)^2 \times \left[ \frac{WB}{2} + WT \times \frac{WT \times D}{S} \right] (ft - lbs)
\]
6) Select a bumper (from the bumper dimension chart on page 12) with an energy absorption capacity (E.A.C.) equal or greater than BE calculated in step 5.

7) In a similar manner calculate the energy (ft-lbs) at 20% of full speed.

\[ BE_{20\%} = \left( \frac{0.2 \times VB}{231840} \right)^2 \times \left( \frac{WB}{2} + WT - \frac{WT \times D}{S} \right) \text{ (ft-lbs)} \]

With your calculated energy absorption requirement (ft-lbs), from step 7, enter the diagram's left upper corner on a line which represents the chosen bumper size.

Interpolate and pinpoint the energy requirement on this line and draw a vertical line down until you intersect the curve in the left most diagram.

From this intersection draw a horizontal line to the left and to the right.

Where the left line intersects with the chosen bumper line the deflection (DE in inches) for your deceleration calculation is shown.

Where the line intersects with the curve in the right diagram draw another line straight up until you again intersect with your chosen bumper size line.

You can read your maximum force on the point of intersection, (tonnes) at 20%, 33% or your own substituted speed value, respectively.

**DECELERATION REQUIREMENT FOR BRIDGE: OSHA**

8) Determine deceleration (a) by using:

\[ a = \left( \frac{0.2 \times VB}{600 \times DE} \right) \text{ (ft/sec}^2) \]

DE (deflection) in inches will be found on the deflection scale of the maximum force diagram for the bumper selected in step 6 and the energy absorption determined in step 7.

The result of this calculation must be 3.0 ft/sec\(^2\) or less.
Example: Correctly size the OSHA required bumpers for the following application. Assume 25 ton crane traveling 150 FPM on 15" end trucks with a 60'-0" span and hook approach (D) of 2'-0".

Required Information:

\[
\begin{align*}
S &= 60 \text{ ft.} \\
D &= 2 \text{ ft.} \\
VB &= 150 \text{ FPM} \\
WB &= 10000 \text{ #} \\
WT &= 3000 \text{ #}
\end{align*}
\]

The bumper calculation only takes into account the impact forces due to the dead load of the crane, the lifted load or live load is assumed negligible because at impact the load will swing and not transfer any impact.

Solution:

OSHA requires that the bumper must have the capacity to absorb the impact energy (BE) at 40% rated speed.

\[
BE_{40\%} = 122.7 \text{ ft-lbs}
\]

Select a bumper that meets or exceeds this value.

Given this information the proper bumper can be selected from the chart on page 12. The appropriate selection would be the size R3 bumper with an Energy Absorption Capacity (E.A.C.) of 145 ft-lbs.

OSHA requires that the deceleration rate (a) not exceed 3.0 ft/sec\(^2\) at 20% rated speed. For the deceleration equation the deflection is needed and must be taken from the curves. Follow the instructions provided with the curves to determine the deflection.

\[
\begin{align*}
BE_{20\%} &= 30.7 \text{ ft-lbs} \\
DE_{20\%} &= 0.53 \text{ in.} \\
a &= 2.83 \text{ ft/sec}^2 \text{ ACCEPTABLE}
\end{align*}
\]

Conclusion: For the given application the bumper has been sized correctly for deceleration and impact energy absorption according to OSHA standards.

---

**ROTATING AXLE END TRUCKS**

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<thead>
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<th>NLGI Rating</th>
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<td>*Recommended re-greasing interval</td>
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*For ambient temperatures above 200°F half the recommended re-greasing interval.

All end trucks are supplied with MOBIL™ AW-2 multi-purpose premium industrial grease for the wheel bearings. This grease is recommended for indoor use under normal loading conditions, if crane is being operated in extreme temperatures or is exposed to the weather refer to this chart for the correct lubrication to be used.

The use of any of these lubricants could affect the delivery time of the end truck since these are not stocked items, consult factory for availability on these special lubricants.

Page 14
### ROTATING AXLE END TRUCKS

#### DIMENSIONS

<table>
<thead>
<tr>
<th>Wheel Diameter</th>
<th>Gear Reducer</th>
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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<th>R</th>
<th>S</th>
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J.H.* Equals the Approximate Height Truck Must Be Raised to Remove Wheel and Axle Assembly.

U** Rail Sweep Notch Width for 55# - 105# Rail (12,15 & 18")

U** Rail Sweep Notch Width for 40# - 60# Rail (9" Truck)
WARRANTY

WARRANTY AND LIMITATION OF REMEDY AND LIABILITY

A. Seller warrants that its products and parts, when shipped, and its work (including installation, construction and start-up), when performed, will meet applicable specifications, will be of good quality and will be free from defects in material and workmanship. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within two (2) years (or as otherwise provided) from shipment of the applicable item unless Seller specifically assumes installation, construction or start-up responsibility. All claims for defective work must be made in writing immediately upon discovery and, in any event, within two (2) years (or as otherwise provided) from completion of the applicable work by Seller, provided, however, all claims for defective products and parts must be made in writing no later than thirty (30) months after shipment. Defective items must be held for Seller’s inspection and returned to the original f.o.b. point upon request. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. Upon Buyer’s submission of a claim as provided above and its substantiation, Seller shall, at its option, either (i) repair or replace its product, part or work at either the original f.o.b. point of delivery or at Seller’s authorized service station nearest Buyer or (ii) refund an equitable portion of the purchase price.

C. This warranty is contingent upon Buyer’s proper maintenance and care of Seller’s products, and does not extend to normal wear and tear. Seller reserves the right to void warranty in event of Buyer’s use of inappropriate materials in the course of repair or maintenance, or if Seller’s products have been dismantled prior to submission to Seller for warranty inspection.

D. The foregoing is Seller’s only obligation and Buyer’s exclusive remedy for breach of warranty, and is Buyer’s exclusive remedy hereunder by way of breach of contract, tort, strict liability or otherwise. In no event shall Buyer be entitled to or Seller liable for incidental or consequential damages. Any action for breach of this warranty must be commenced within two (2) years (or as otherwise provided) after the cause of action has accrued.