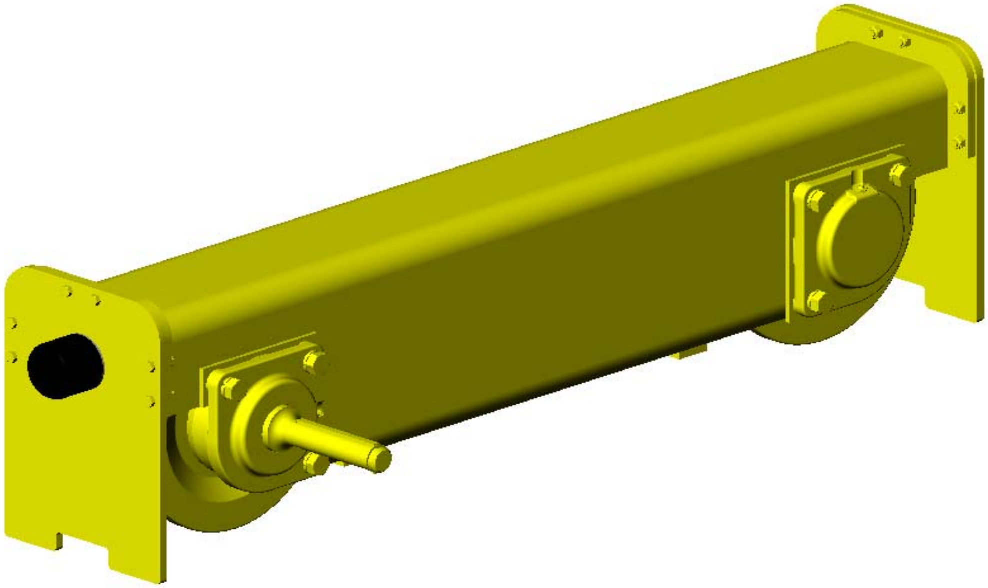
ROTATING AXLE END TRUCKS



SPECIFICATIONS
APPLICATION DATA
DIMENSIONS

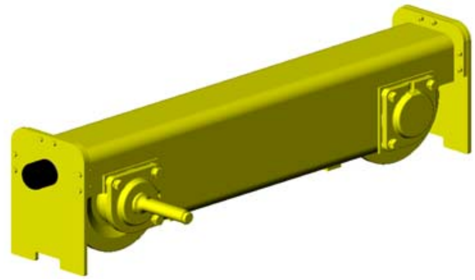
This manual contains engineering specifications and application data for the tube style top running rotating axle end trucks.

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.

ROTATING AXLE END TRUCKS

SPECIFICATIONS

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

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

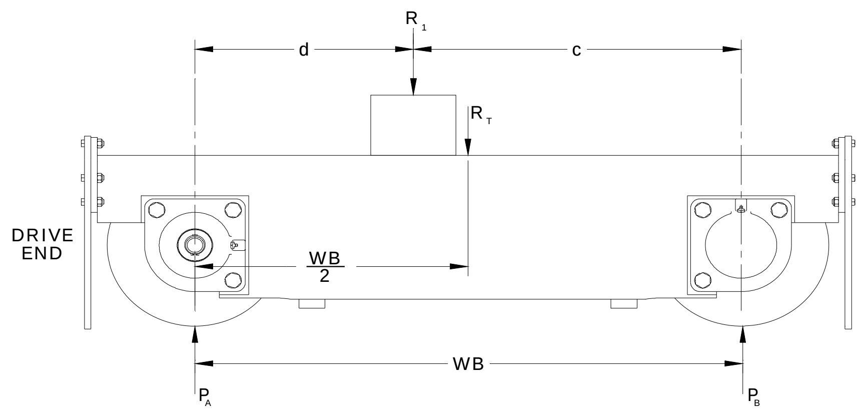
SPECIFICATIONS

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.

ROTATING AXLE END TRUCKS

APPLICATION DATA FOR SINGLE CONCENTRATED LOAD



* Position trolley adjacent to end truck for reaction calculations.

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)

Trolley Dead Load Bending Moment:

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

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

Trolley Live Load Bending Moment:

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

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

End Truck Dead Load Bending Moment:

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

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

Bridge Dead Load Bending Moment:

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

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

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

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

use BM_A or BM_B, which should be equal, to apply vertical inertia factors HLF and DLF.

VERTICAL BENDING MOMENT:

$$✞\ DLF = 1.1 \le 1.05 + \frac{TravelSpeed(FPM)}{2000} \le 1.2$$

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

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.

ROTATING AXLE END TRUCKS

SINGLE CONCENTRATED LOAD EXAMPLE CALCULATION

Wheel Diameter	Allowable Equivalent Durability Wheel Load (P_e Allowable) (pounds)				Maximum Allowable Bending Moment (inch-pounds)
	ASCE 20#	ASCE 40#	ASCE 60# & 70# ARA-B 100#	ASCE 80# & 85# ARA-A 100# BETH 104# USS 105#	
9	11,300	16,800	*23600		784,000
12		22,400	31,400	*33,700	1,234,000
15		28,000	39,300	*42,100	1,907,000
18		33,700	47,200	*50,500	3,554,000
Effective Rail Head Width (inch)	0.844	1.250	1.750	1.875	

* 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 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:

R_{1DLT} =	3500	#	c =	80	in.
R_{1LLT} =	17000	#	d =	40	in.
R_{1DLB} =	15000	#	WB =	120	in.
R_1 =	35500	#	DLF =	1.10	
***Assumed* R_T =	1180	# (12" end truck)	HLF =	1.15	
Runway Rail =	40	#/yd			

Solution:

ACTUAL Wheel Load at P_A =	24257	#	BM_{ADLT} =	93333	in-#
ACTUAL Wheel Load at P_B =	12423	#	BM_{BDLT} =	93333	in-#
P_{ADLT} =	2333	#	BM_{ALLT} =	453333	in-#
P_{BDLT} =	1167	#	BM_{BLLT} =	453333	in-#
P_{ALLT} =	11333	#	BM_{ADLB} =	400000	in-#
P_{BLLT} =	5667	#	BM_{BDLB} =	400000	in-#
P_{ADLB} =	10000	#	BM_{AET} =	15733	in-#
P_{BDLB} =	5000	#	BM_{BET} =	15733	in-#
			BM_A =	962400	in-#
			BM_B =	962400	in-#

Vertical Bending Moment:

BM_{DLT} =	93333	x DLF	1.10	=	102667	in-#
BM_{LLT} =	453333	x HLF	1.15	=	521333	in-#
BM_{DLB} =	400000	x DLF	1.10	=	440000	in-#
BM_{ET} =	15733	x DLF	1.10	=	17307	in-#
				BM_V =	1081307	in-#

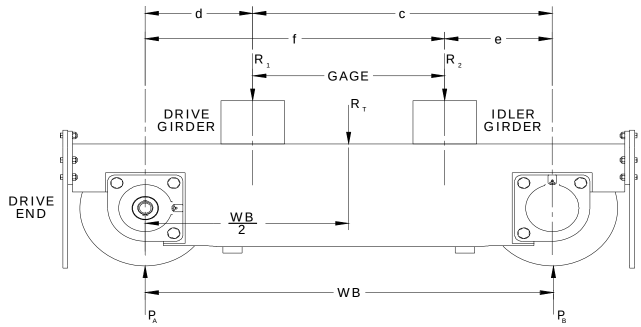
Selection: Select an end truck from wheel load/bending moment chart above with an allowable wheel load of 24,257# or more and an allowable bending moment of 1,081,307 in-# or more for the runway rail size being used. **15" Truck Selected**

Suggestion: By increasing d up to a maximum of (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.

ROTATING AXLE END TRUCKS

APPLICATION DATA FOR TWO CONCENTRATED LOADS



ACTUAL Wheel Load at P_A:

$$P_A = \left(\frac{R_1 \times c}{WB}\right) + \left(\frac{R_2 \times e}{WB}\right) + \frac{R_T}{2}$$

ACTUAL Wheel Load at P_B:

$$P_B = \left(\frac{R_1 \times d}{WB}\right) + \left(\frac{R_2 \times f}{WB}\right) + \frac{R_T}{2}$$

Where:

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

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

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

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

R_T = End truck dead weight (lbs)

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

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

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

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

* Position trolley adjacent to end truck for reaction calculations.

Trolley Dead Load Bending Moment:

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

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

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

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

Trolley Live Load Bending Moment:

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

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

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

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

End Truck Dead Load Bending Moment:

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

$$BM_{B_{ET}} = \left(\frac{R_T \times e}{2 \times WB}\right) \times f$$

Bridge Dead Load Bending Moment:

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

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

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

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

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

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

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

VERTICAL BENDING MOMENT:

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

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

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.

✞ Taken from CMAA specification #70 and #74, revised 2000.

ROTATING AXLE END TRUCKS

TWO CONCENTRATED LOADS EXAMPLE CALCULATIONS

Wheel Diameter	Allowable Equivalent Durability Wheel Load (P_e Allowable) (pounds)				Maximum Allowable Bending Moment (inch-pounds)
	ASCE 20#	ASCE 40#	ASCE 60# & 70# ARA-B 100#	ASCE 80# & 85# ARA-A 100# BETH 104# USS 105#	
9	11,300	16,800	*23600		784,000
12		22,400	31,400	*33,700	1,234,000
15		28,000	39,300	*42,100	1,907,000
18		33,700	47,200	*50,500	3,554,000
Effective Rail Head Width (inch)	0.844	1.250	1.750	1.875	

* 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	#	c =	100	in.
R_{1LLT} =	20000	#	d =	20	in.
R_{1DLB} =	5800	#	e =	28	in.
R_1 =	27000	#	f =	92	in.
R_{2DLT} =	1200	#	GAGE =	84	in.
R_{2LLT} =	8000	#	WB =	120	in.
R_{2DLB} =	5800	#	DLF =	1.10	
R_2 =	15000	#	HLF =	1.15	
***Assumed* R_T =	1180	# (12" end truck)	Runway Rail =	40	#/yd

Solution:

ACTUAL Wheel Load at P_A =	26590	#	BM_{ADLT} =	25600	in-#
ACTUAL Wheel Load at P_B =	16590	#	BM_{BDLT} =	31360	in-#
P_{ADLT} =	1280	#	BM_{ALLT} =	370667	in-#
P_{BDLT} =	1120	#	BM_{BLLT} =	265067	in-#
P_{ALLT} =	18533	#	BM_{ADLB} =	123733	in-#
P_{BLLT} =	9467	#	BM_{BDLB} =	151573	in-#
P_{ADLB} =	6187	#	BM_{AET} =	9833	in-#
P_{BDLB} =	5413	#	BM_{BET} =	12665	in-#
			BM_A =	529833	in-#
			BM_B =	460665	in-#

Vertical Bending Moment:

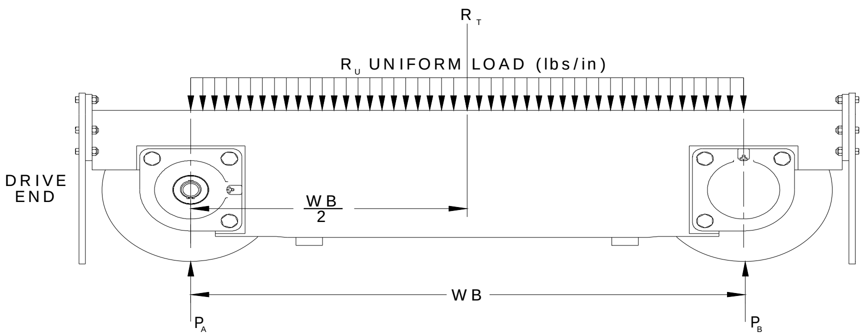
BM_{DLT} =	25600	x DLF	1.10	=	28160	in-#
BM_{LLT} =	370667	x HLF	1.15	=	426267	in-#
BM_{DLB} =	123733	x DLF	1.10	=	136107	in-#
BM_{ET} =	9833	x DLF	1.10	=	10817	in-#
				BM_V =	601350	in-#

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.

ROTATING AXLE END TRUCKS

APPLICATION DATA FOR UNIFORM LOADING



ACTUAL Wheel Load at P_A:

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

ACTUAL Wheel Load at P_B:

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

Where:

RU = Uniform Dead Load (lbs/in)
RT = End Truck Dead Weight (lbs)
WB = End Truck Wheelbase (in)

Uniform Dead Load Bending Moment:

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

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

✞ 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 x 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

Wheel Diameter	Allowable Equivalent Durability Wheel Load (P_e Allowable) (pounds)				Maximum Allowable Bending Moment (inch-pounds)
	ASCE 20#	ASCE 40#	ASCE 60# & 70# ARA-B 100#	ASCE 80# & 85# ARA-A 100# BETH 104# USS 105#	
9	11,300	16,800	*23600		784,000
12		22,400	31,400	*33,700	1,234,000
15		28,000	39,300	*42,100	1,907,000
18		33,700	47,200	*50,500	3,554,000
Effective Rail Head Width (inch)	0.844	1.250	1.750	1.875	

* 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.

** *Assumed* 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 x DLF 1.15 = 1685756 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.

ROTATING AXLE END TRUCKS

APPLICATION DATA FOR EQUIVALENT DURABILITY WHEEL LOADS

✞ $$P_e = P_{MAX} \times K_{WL}$$

P_e = Equivalent Durability Wheel Load
P_{MAX} = Maximum Actual Wheel Load
K_{WL} = Wheel Load Service Coefficient

✞ $$K_{WL} = K_{BW} \times C_S \times S_M$$

K_{BW} = Bridge Wheel Load Factor
C_S = Speed Factor
S_M = Wheel Service Factor

Speed Factor Equation:

$$RPM = \frac{V_B \times 12}{\pi \times d}$$

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

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

Bridge Wheel Load Factor Equation:

✞ $$K_{BW} = \frac{.75(BW) + F(LL) + .5(TW) - .5F(TW)}{.75(BW) + 1.5F(LL)}$$

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

✞ CLASS OF CRANE SERVICE	C	D
*K_{WL} min.	0.80	0.85
S_M	1.00	1.12

* 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.

ROTATING AXLE END TRUCKS

EQUIVALENT DURABILITY WHEEL LOAD EXAMPLE CALCULATIONS

Wheel Diameter	Allowable Equivalent Durability Wheel Load (P_e Allowable) (pounds)				Maximum Allowable Bending Moment (inch-pounds)
	ASCE 20#	ASCE 40#	ASCE 60# & 70# ARA-B 100#	ASCE 80# & 85# ARA-A 100# BETH 104# USS 105#	
9	11,300	16,800	*23600		784,000
12		22,400	31,400	*33,700	1,234,000
15		28,000	39,300	*42,100	1,907,000
18		33,700	47,200	*50,500	3,554,000
Effective Rail Head Width (inch)	0.844	1.250	1.750	1.875	

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

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_{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

RPM = 63.7 Bridge Wheel Speed of Rotation

C_S = 1.098

S_M = 1.00
K_{WL} (min) = 0.80
For Class C Service

K_{WL} = 0.810 If K_{WL} is less than K_{WL} (min) use K_{WL} (min) otherwise use K_{WL}.

Pe = 19433 # **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 = Total Bridge Weight (Girders, Footwalks, End Trucks, Bridge Mounted Controls, Drives, etc.) (lbs.)
W_T = Hoist and Trolley Weight (lbs.)
LL = Live Load and Below the Hook Lifting Devices (lbs.)
W = Total Driven Load = $\dfrac{(W_B + W_T + LL)}{2000}$ (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:

✟ $$K_A = \frac{f + \left(\dfrac{2000a \times C_r}{g \times E}\right)}{33{,}000 \times K_t} \times \frac{N_r}{N_f}$$

For AC Motors N_r/N_f 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

  ✟ $C_r = 1.05 + \left(\dfrac{a}{7.5}\right)$
- g = Gravitational Constant 32.2 (ft/sec^2)
- 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)

CMAA Service Class	AC Inverter AC Magnetic Adjustable Voltage w/DC Shunt Motors
C	1.0
D	1.1

FOR OTHER CONTROL TYPES CONTACT FACTORY

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

Wheel Dia inches	18	15	12	10	8	6
Friction lbs/ton	15	15	15	15	16	16

Use for 9" Wheel (arrow to 8 column)

✟ Taken from CMAA specification #70 and #74, revised 2000. Excerpts of *drive service factor* and *friction factor* charts shown.

✞ Table 3* Max. Acceleration Rate to Prevent Skidding		
Percent of Driven Wheels	50	25
Dry Rail (0.2 coeff. of friction)	2.4	1.2
Wet Rail (0.12 coeff. of friction)	1.5	0.7

✞ Table 4* Typical Acceleration Rate Range		
Free Running Full Load Speed		a = Acceleration Rate for AC and DC Motors
Ft. Per Min.	Ft. per Sec.	
60	1.0	0.25 min
120	2.0	0.25 - 0.80
180	3.0	0.30 - 1.00
240	4.0	0.40 - 1.00
300	5.0	0.50 - 1.10

* Use Table 4 to get an acceleration rate for your application, the acceleration rate must be less than the appropriate value in Table 3 to prevent wheel skidding.

✞ Taken from CMAA specification #70 and #74, revised 2000. Excerpt of *maximum acceleration rate to prevent skidding* chart 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:

Bridge Girder Weight =	14000	#	f (rolling friction factor) =	15
Weight of Selected End Trucks =	3450	#	a (acceleration factor) =	0.35
Estimated Drive Weight =	1300	#	Cr (rotational inertia factor) =	1.10
Weight of Hoist/Trolley =	1500	#	g (gravitational constant) =	32.2
Total Crane Dead Weight =	20250	#	E (mechanical efficiency) =	0.95
Total Live Load =	20000	#	V (rated drive speed) =	120
Total Driven Load =	40250	#	Kt (accelerating torque factor) =	1.30
Driven Load (Total Driven Load/2000) (W) =	20.125	Tons	Ks (Service Factor) =	1.00

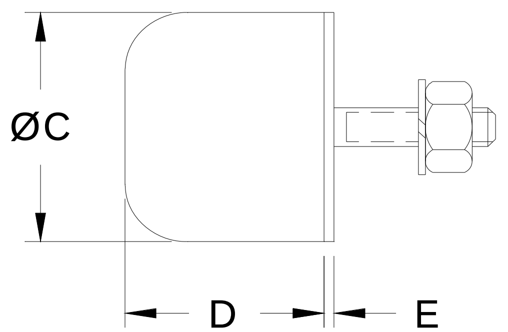
Solution:

Ka = 0.0009346

Total Required HP = 2.26

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.



Bumper	E.A.C.	"C" Dia. (in)	Length (in)	"D" Dim.	"E" Dim.
R1	38	1.6	1.38	1.3	0.08
R2	75	2.0	1.68	1.6	
R3	145	2.5	2.12	2.0	0.12
R4	290	3.2	2.62	2.5	
R5	578	4.0	3.36	3.2	0.16
R6	1155	5.0	4.16	4.0	
R7	2310	6.4	5.24	5.0	0.24
R8	4550	8.0	6.64	6.4	

DETERMINATION OF BUMPER SIZES

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/sec^2).

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

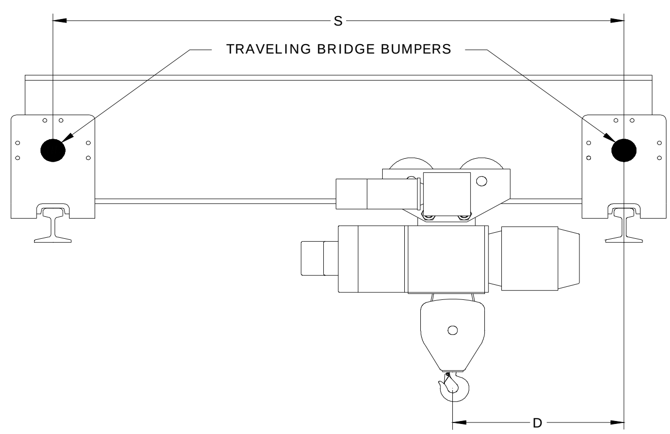
The bumpers, usually two, must be large enough to absorb the impact energy (ft-lbs) at 40% of full speed. Deceleration must not exceed 3.0 ft/sec^2 at 20% of full speed.

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:

$$BE_{40\%} = \left(\frac{(0.4 \times VB)^2}{231840} \right) \times \left[\frac{WB}{2} + WT - \frac{WT \times D}{S} \right] (ft - lbs)$$

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.

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

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**.

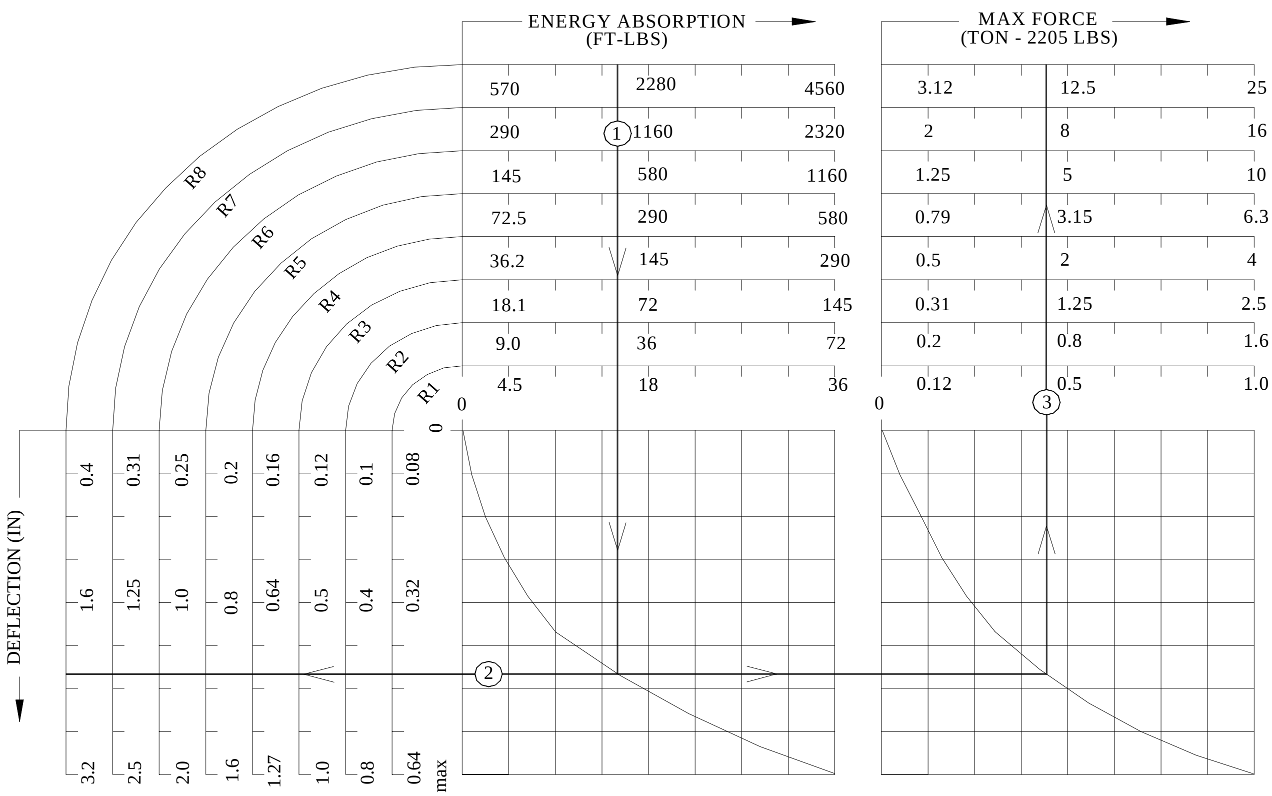
Interpolate and pinpoint the energy requirement on this line and draw a vertical line down until you intersect the curve in the left most diagram.

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:

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

Note: At full deflection the bumper diameter will expand to 1.7 times it's normal diameter, **LEAVE ENOUGH SPACE.**

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.

ROTATING AXLE END TRUCKS

BUMPER EXAMPLE CALCULATION

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:

S = 60 ft.
D = 2 ft.
VB = 150 FPM
WB = 10000 #
WT = 3000 #

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 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.

$BE_{20\%}$ = 30.7 ft-lbs

$DE_{20\%}$ = 0.53 in.

a = 2.83 ft/sec^2 **ACCEPTABLE**

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

LUBRICATION SPECIFICATION

NLGI Rating	2	2	1
Ambient Temperature Range (°F)	-20°F to 50°F	50°F to 125°F	125°F to 250°F
ASTM Worked Penetration	265 - 295	265 - 295	310 - 340
Dropping Point	475+	475+	475+
Base	Lithium Base	Lithium Base	Lithium Base
9" Truck	MOBILITH SHC® 100	MOBILITH SHC® 220	MOBILITH SHC® 1500
12" Truck	MOBILITH SHC® 100	MOBILITH SHC® 220	MOBILITH SHC® 1500
15" Truck	MOBILITH SHC® 100	MOBILITH SHC® 220	MOBILITH SHC® 1500
18" Truck	MOBILITH SHC® 100	MOBILITH SHC® 220	MOBILITH SHC® 1500
*Recommended re-greasing interval	3 months	3 months	3 months

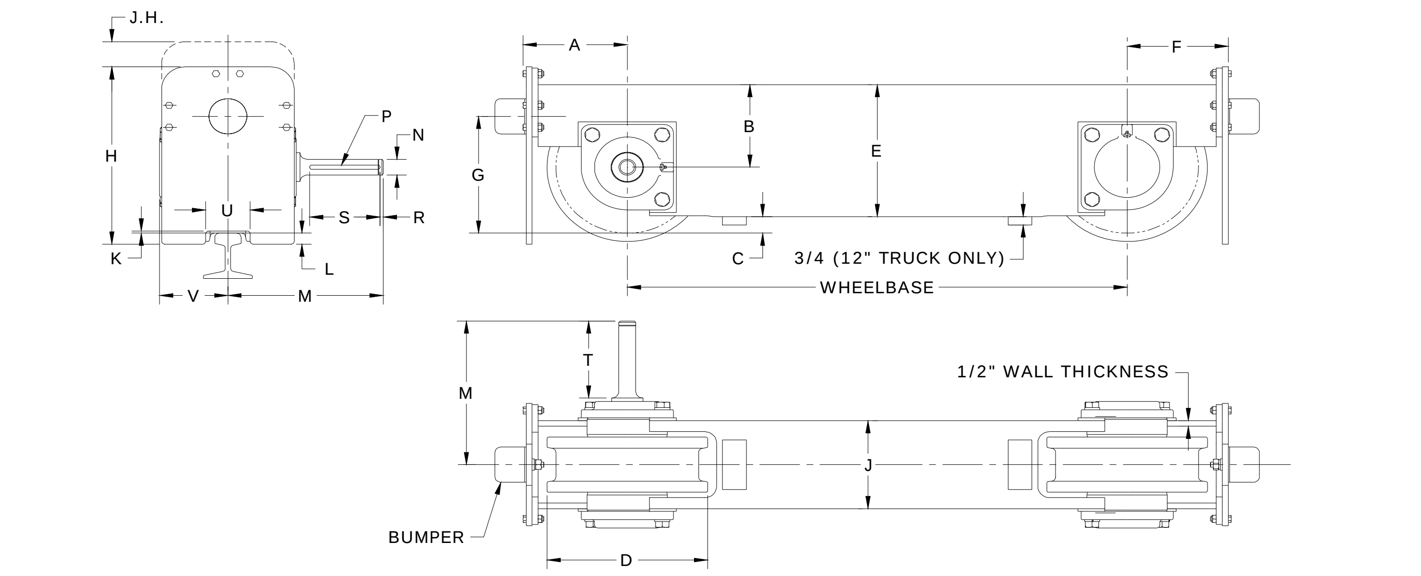
*For ambient temperatures above 200°F half the recommended re-greasing interval.

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.

ROTATING AXLE END TRUCKS

DIMENSIONS



Wheel Diameter	Gear Reducer	A	B	C	D	E	F	G	H	J	K	L
9	LT2282 LT3282 CENTER	6 3/8	6	1/2	10	10	6 3/16	7 1/2	12 11/16	6	3/16	13/16
12	LT2282 LT3282 LT4282 CENTER	8 3/4	7 1/2	1 1/2	13 1/2	12	8 1/2	10 5/8	16 1/8	8	3/16	1
15	LT3282 LT4282 LT5282 CENTER	9 13/16	9 1/2	1	17	16	9 1/2	13 7/8	20 1/8	8	3/16	1 1/4
18	LT4282 LT5282 LT6282 CENTER	12 9/16	12	1	20	20	12	16 7/8	25	12	3/16	1 3/8

Wheel Diameter	Gear Reducer	M	N (nom.)	P KEY	R	S	T	J.H.*	U**	V
9	LT2282 LT3282 CENTER	11 3/8 12 1/2 9 3/8	1.435 1.623 1.5625	3/8 x 3/8 3/8 x 1/4 3/8 x 3/8	1/4 1/4 1/8	5 15/16 7 3/16 3 5/16	6 5/8 ------- 3 1/4	1	3 5/8	4 7/8
12	LT2282 LT3282 LT4282 CENTER	13 1/16 14 3/16 15 3/16 17 11/16	1.435 1.623 2.060 2.4372	3/8 x 3/8 3/8 x 1/4 1/2 x 3/8 5/8 x 5/8	1/4 1/4 1/4 1/8	5 15/16 7 3/16 8 5/16 4 1/16	7 8 1/8 9 1/8 4	1 1/2	3 3/4	5 3/4
15	LT3282 LT4282 LT5282 CENTER	15 1/16 16 3/16 17 3/8 17 1/2	1.623 2.060 2.436 2.9372	3/8 x 1/4 1/2 x 3/8 5/8 x 5/8 3/4 x 3/4	1/4 1/4 1/4 1/8	7 3/16 8 5/16 9 11/16 4 1/8	8 3/8 9 1/4 10 1/2 4 1/8	2	3 3/4	6 1/2
18	LT4282 LT5282 LT6282 CENTER	19 1/4 20 1/2 22 3/4 19 1/4	2.060 2.436 2.748 3.187	1/2 x 3/8 5/8 x 5/8 5/8 x 5/8 3/4 x 3/4	1/4 1/4 1/4 1/4	8 5/16 9 11/16 12 3/16 5 1/4	9 1/2 10 3/4 13 1/8 5	1 7/8	3 3/4	9 9/32

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 products or parts when Seller specifically assumes installation, construction or start-up responsibility, and 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.

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