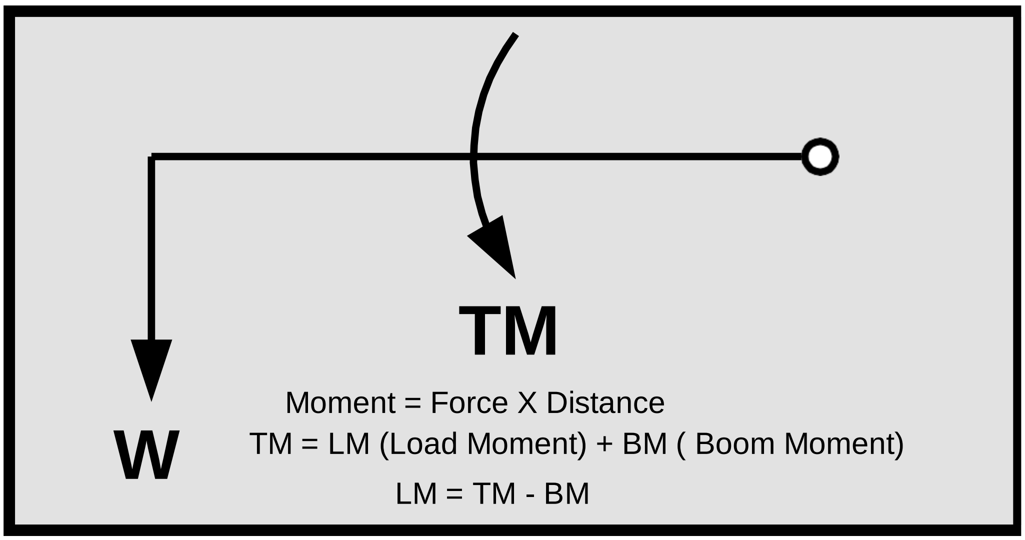
Rated Capacity Indicator/Limiter System

Principles of Operation



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Rated Capacity Indicator/Limiter System
Table of Contents

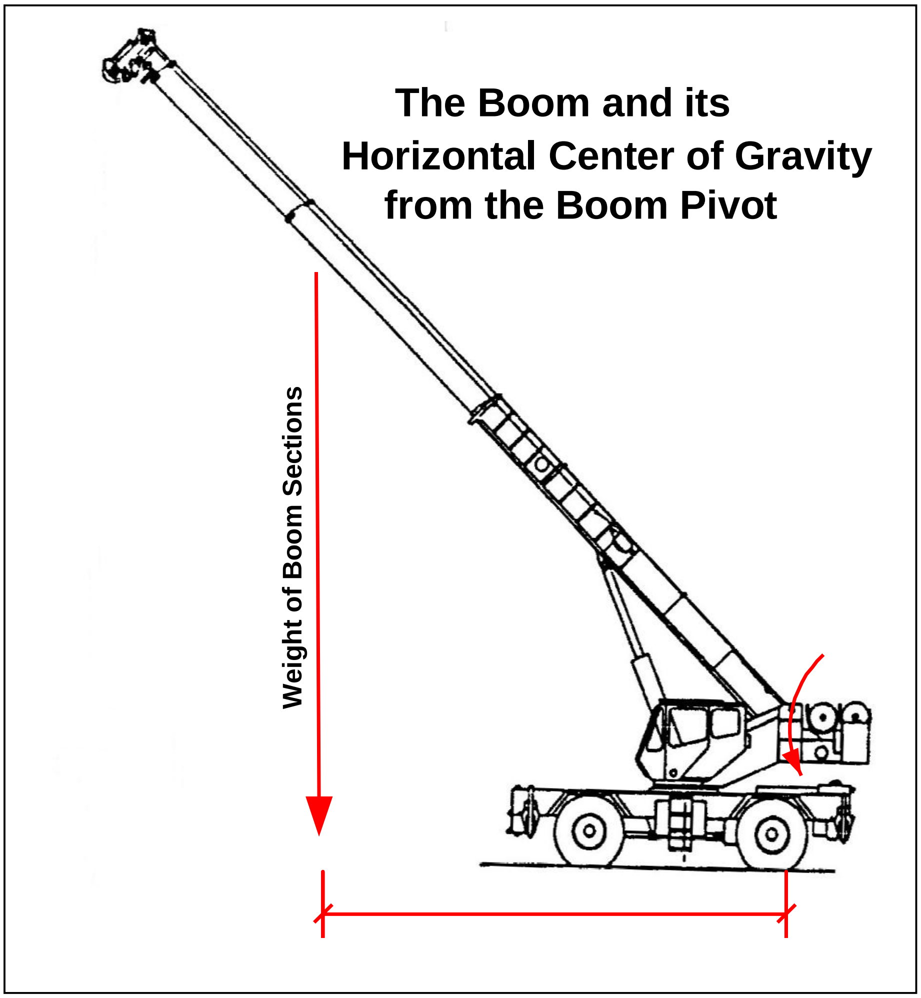
Fundamentals of Load Moment

"Moment" is the tendency to cause rotation about a point or axis.

"**Total Moment**," which is comprised of the following two parts, is the basis for all Greer system operations.

- The weight of the boom and the horizontal center of gravity of the boom.
- The weight of the load, load handling equipment, and the winch cable (essentially, anything below the head of the boom).

"**Boom Moment**" is the weight and horizontal center of gravity of the sections of the boom relative to the hinge point of the boom.



Measuring the Moment of the Boom

Fundamentals of Load Moment continued

”**Moment of the Load**” (Load Moment) is the weight of the load X the distance from the boom pivot. (The weight includes everything under the boom head such as, cable, slings, handling equipment, and the load itself.)

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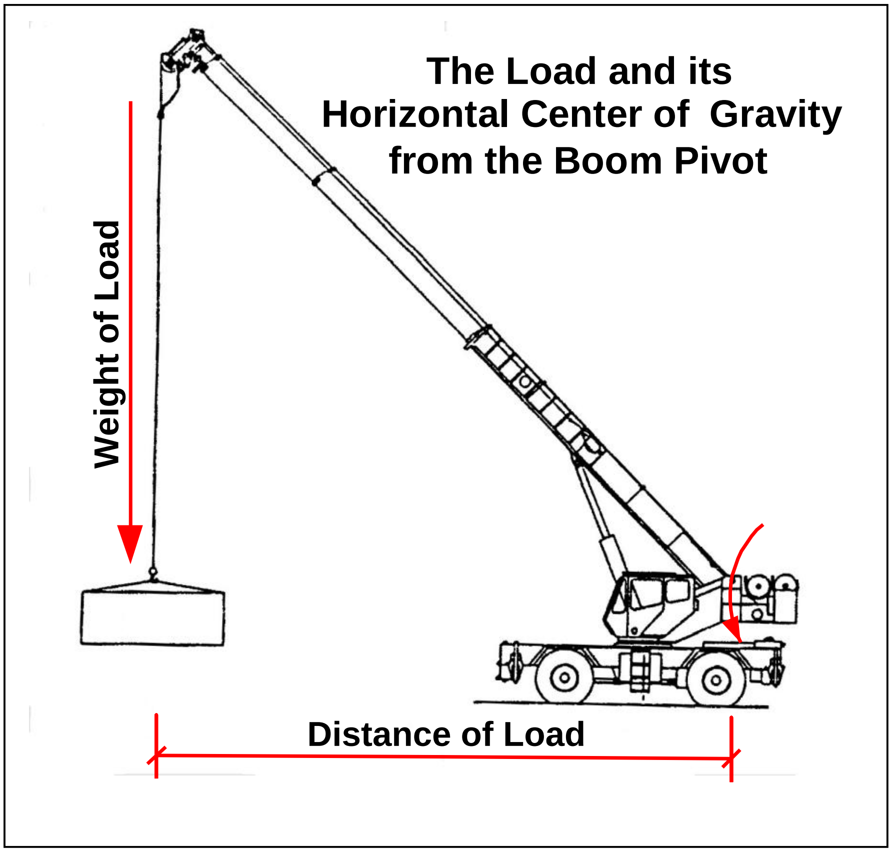


Measuring the Moment of the Load

Fundamentals of Load Moment continued

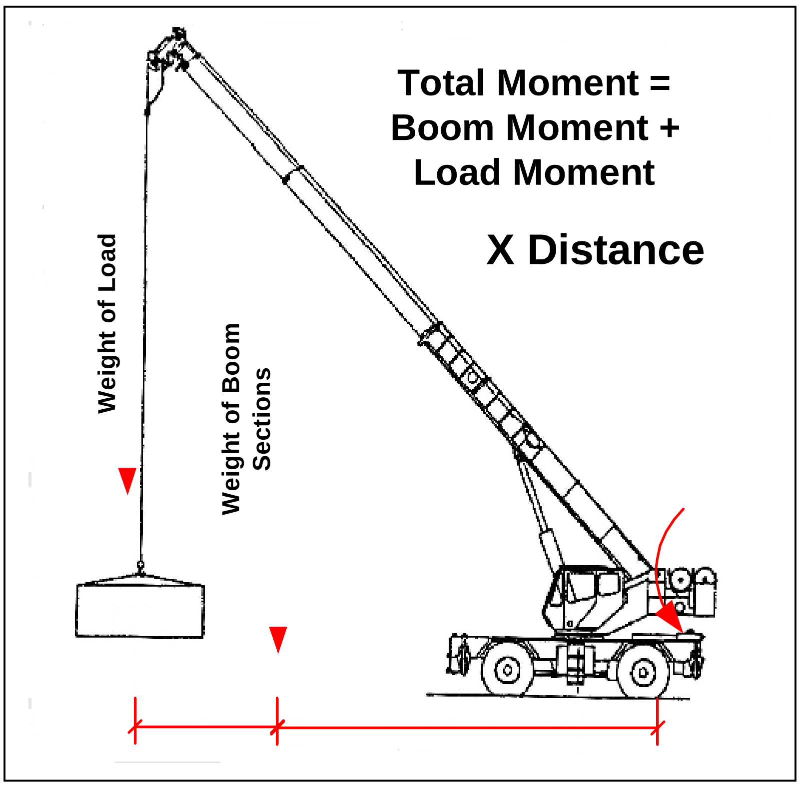
"**Total Moment**" is "Boom Moment" plus "Load Moment" X the distance from the boom pivot (hinge point).

The Greer Company load moment computer performs extensive calculations to provide the information necessary for the system to display accurate loads on the screen.
All of the information seen on the screen is based on the following:

Total Moment = Boom Moment + Load Moment X Distance from Hinge Point

Boom Moment = Total Moment – Load Moment

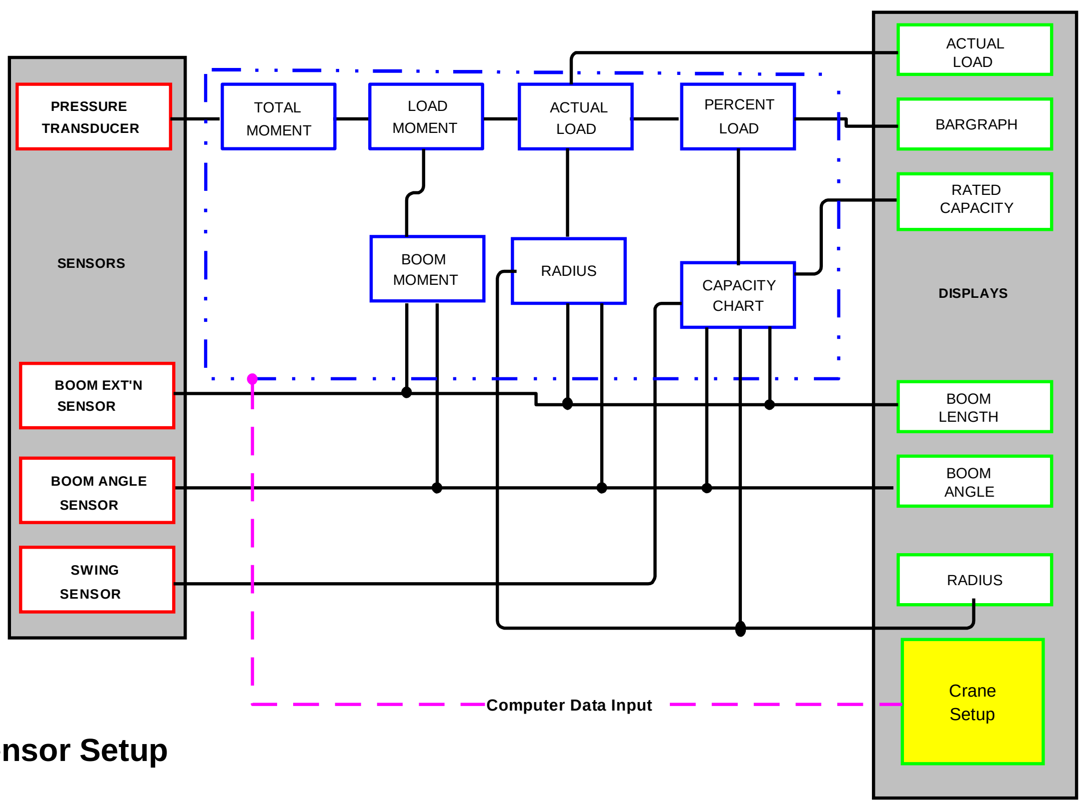
Load Moment = Total Moment – Boom Moment



Measuring Total Moment

Rated Capacity Indicator/Limiter System

- The Rated Capacity Indicator/Limiter System provides a comparison of the actual load with the rated load. Rated load is the maximum lifting capacity of a crane as specified by its load chart.
- Load chart parameters for determining rated load are: length/angle/radius and actual load. An allowance is also computed into the rated load for any unused attachments either stowed or erected that are not currently being used in the lifting operation but, by being stowed or erected, reduce the available capacity. These are commonly called deducts and are a standard item on a crane capacity chart.
- Actual Load is the load suspended at the lifting point and includes the hook-block or ball and any slings or attachments used and the load.
- The system computes actual load by a method described as total moment. Total Moment is the moment created by the load, boom, and all attachments.
- Input data for calculation of moment of the boom consists of boom angle, boom extension and boom lift cylinder pressure. All of this information is gathered from various sensors on the crane. These inputs are listed in the following diagram with explanations on the following pages.



System Sensor Setup

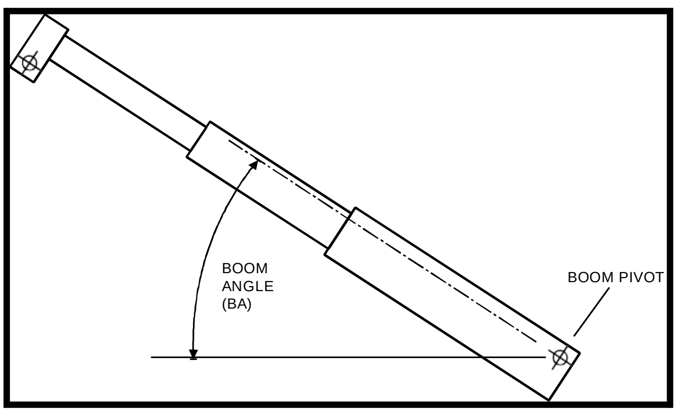
Boom Angle

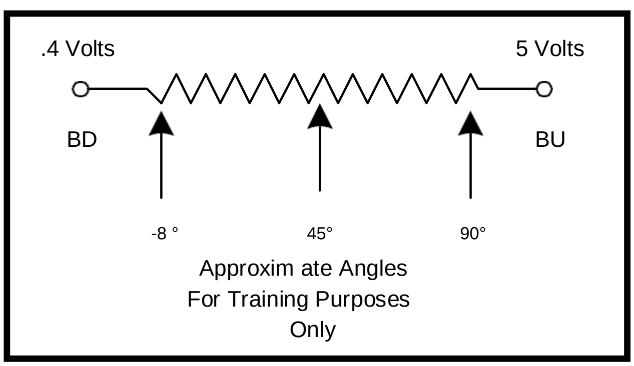
Boom angle is the angle of the working boom relative to a horizontal (level) position, as calculated by an angle sensor installed on the first projecting segment of the boom.
Refer to the illustration below.

The angle sensor includes a high-accuracy potentiometer that uses a magnetically dampened copper pendulum. This pendulum, which is connected to the shaft of the potentiometer, tracks boom angle movement, providing a linear change in voltage proportional to the actual boom angle. The acceptable span, based on the manufacturer's requirement, is from –15 º to +90 º.

The boom angle sensor provides a display of the boom angle in degrees and tenths of degrees on a digital display.

Typical Boom Angle Measurement



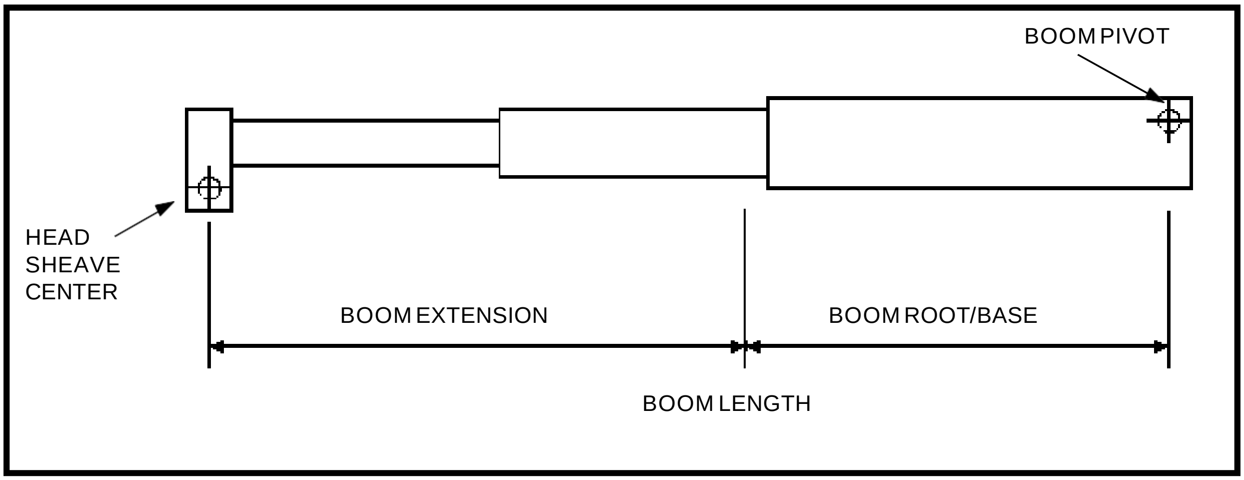


Measuring the Boom Angle

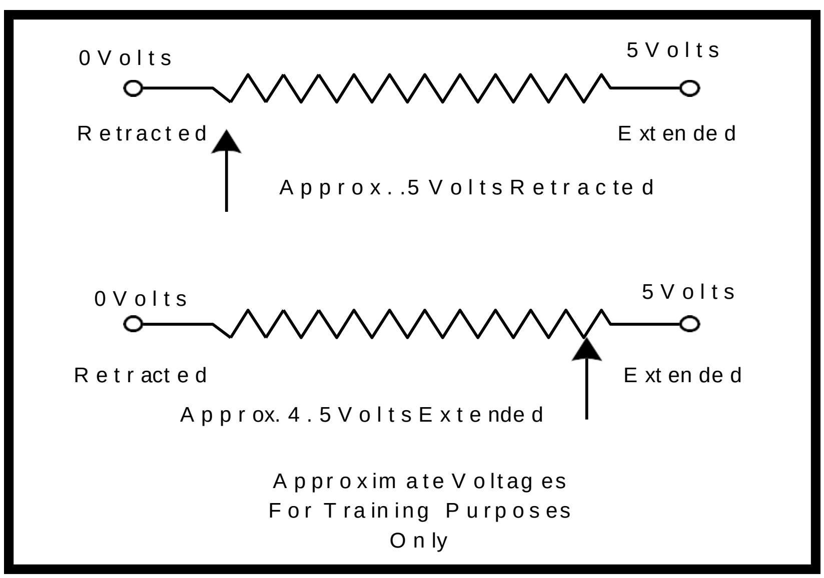
Boom Extension

Boom extension represents the collective measurement of each telescoping section of the boom. The boom extension sensor, which measures boom extension, includes a potentiometer with a 10 turn capacity connected by gears to the shaft of the extension reel. The gear ratio is calculated to require less than 10 turns of the potentiometer shaft for maximum extension. Rotation of the shaft of the potentiometer is proportional to the extension of the boom.

The boom extension signal sent to the computer is determined by the extension of the boom. The data supplied by the extension signal in conjunction with other data entered into the computer during calibration is used to determine the length of the boom.



Typical Extension Measurement



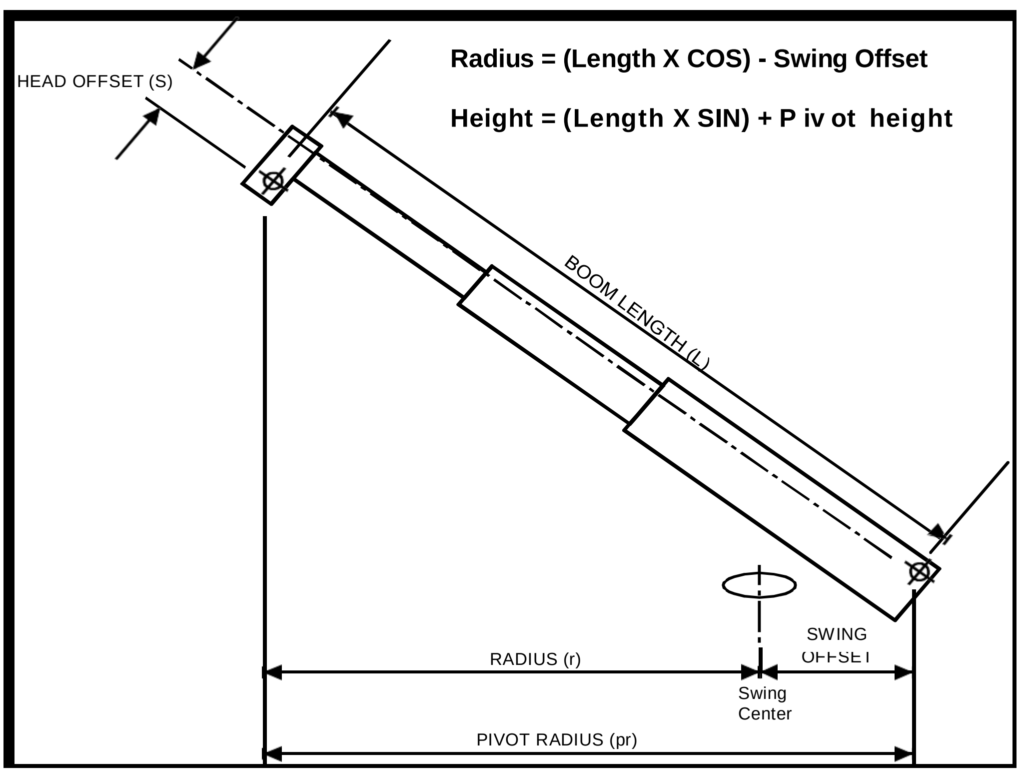
Measuring the Boom Extension

Radius/Height

Computations for RADIUS and HEIGHT are based on the premise that the boom, hoist rope, and horizon form a right angle triangle in which the boom is the hypotenuse.
Using the available information from the boom extension sensor and the boom angle sensor, it is possible to program the computer to calculate the horizontal distance from the boom pivot to the center of the load suspended beneath the boom head. This distance, referred to as "**pivot radius,**" is used by the computer to determine the "**moment of the load.**" Radius is calculated by subtracting swing offset from **pivot radius.**

Computations for the height of the boom head above the boom pivot are also programmed by the computer by modifying the following constants: the height of the **boom pivot** above ground level and the height of the **boom head** above ground level. The accuracy of the height calculation will depend on factors (e.g., extension of outriggers, operation on tires, etc.) that cannot be controlled by the computer.

When operating with multiple parts-of-line, it is normal for the load to be suspended directly under the centerline of the head machinery. The radius computations are based on this assumption.
When operating with one part-of-line, the radius will increase by approximately the radius of the head sheave. To correct this, the radius is increased by this value whenever one part-of-line Is selected.

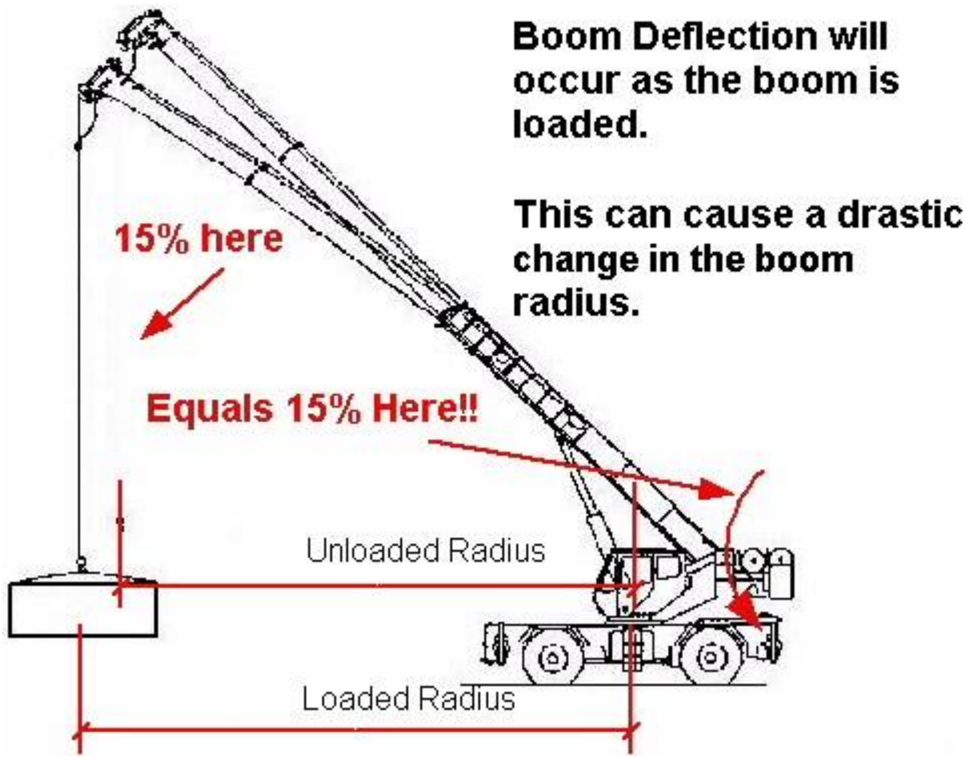


Measuring Radius/Height

Boom Deflection

Remember that boom deflection can also play a part in working with the limits of the unit.

If the load moment system measures a near perfect radius, the deflection in the boom may **still** cause an increase in the load radius **when the load is actually lifted,** which can put the unit into an overload condition. An additional 15% deflection in the boom radius will equal an additional 15% in the total moment the computer is reading.



What effect does boom deflection have?

Rated Load

Rated Load is located in the crane manufacturer's load chart that is stored in the memory of the computer. This data is specific to the crane for which it is produced and contains complete information for determining the maximum safe load in any operational situation.

Pressing the crane setup button initiates the current crane setup function. This function allows input of the current working configuration into the display unit. Interaction between the display unit and the computer provides the computer with the necessary information to determine the Rated Load parameters.

WARNING: If there is ANY CHANGE in the crane configuration, the operator must RESET THE CONFIGURATION.

Factors Determining the Rated Load

- Crane on outriggers or tires
- Counterweight selection (if applicable)
- Boom mode
- Erected attachments
- Hoist in use
- Lifting point; main boom, aux. head, fly/jib
- Stowed attachments
- Parts-of-line in use
- Wire rope strength

Other information required by the computer when determining Rated Load:

The position (over side, over front, and over rear) of the boom in relation to the carrier. (This is accomplished through the use of swing switches or swing potentiometers - depending on the model of the crane.)

Total Moment

The *moment of the load and* the *moment of the boom* are measured in a composite signal described as Total Moment. Total Moment is a method used to determine the actual load. This signal measures the tendency to produce motion about a point or axis, in this case a boom pivot.

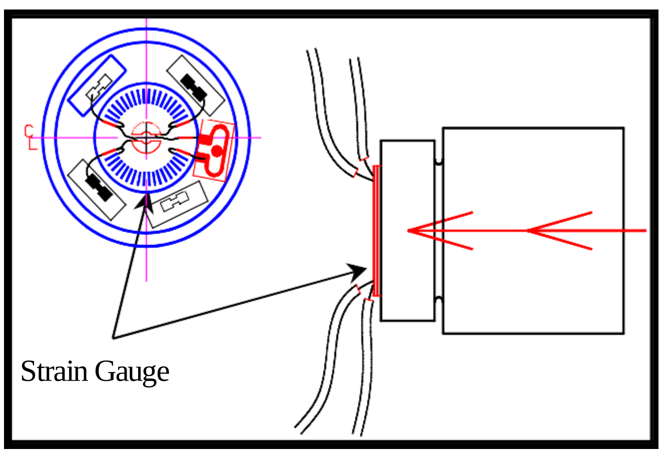
Total moment is measured by means of a pressure transducer connected to the hydraulic oil on the piston side of the boom hoist cylinder.

A Typical Pressure Transducer

A pressure transducer is a device that converts hydraulic pressure into an electrical signal. It operates using strain gauges bonded to a flexible diaphragm.

Strain gauges can be described as resistors that change value when they are either stretched or compressed. As the pressure in the boom hoist cylinder changes, the diaphragm in the pressure transducer changes.

If the resistance in any part of the strain gauge changes, the output of the bridge will also change. Strain gauges are linear devices, meaning that the output is proportional to the pressure applied to the diaphragm.



Typical Wheat Stone Bridge

Summary

All of the foregoing discussions apply to pressure measurements obtained during the lifting of static loads. However when loads are in motion (e.g., as when booming down), there is a tendency for the actual load reading to change. This is usually because 'boom down' is achieved by introducing pressure into the rod side of the boom hoist cylinder. A portion of this pressure, determined by the relative cross-section areas of the boom hoist cylinder, will appear as an increase in pressure in the piston side of the boom hoist cylinder. If not compensated for, this would result in the computer recognizing this increase in pressure as an increase in actual load. Therefore, compensation is achieved by placing a transducer in the rod side of the boom hoist cylinder.

As a recap, MOMENT is the tendency to produce a twisting motion about a point or axis. Two basic components in a moment calculation are Force and Distance.

1. **MOMENT = FORCE x DISTANCE**

   TOTAL MOMENT, in this application, is comprised of the Moment of the Boom and the Moment of the Actual Load at the lifting point.

2. **TOTAL MOMENT = BOOM MOMENT + LOAD MOMENT**

   The angle and length of the boom are measured and used in computations of load and height.

3. The pressure transducers at the bottom of the boom hoist cylinder are providing measurements for Total Moment.
   If the system is measuring Total Moment and calculating Load Moment, the following calculation applies:

   LOAD MOMENT = TOTAL MOMENT – BOOM MOMENT.

Boom Moment

Boom Moment is comprised of Force (Weight of the Boom) and Distance (center of gravity of the boom with respect to the boom pivot). Therefore, all of the information is available from sensors on the crane for the computer to calculate the Boom Moment. The following calculation now applies.

Boom Moment = Force (Weight of the boom) x Distance
(Center of gravity of the boom with respect to the boom pivot)

Percentage of Load

The system displays percentage of load both as a number and on a bar graph display (depending on the computer model). The percentage is calculated from the Rated Load and the Actual Load.
This calculated percentage is used by the computer to initiate three adjustable audible and visual alarms. These alarms may be used only to warn but also, with the use of associated relays, for external alarms. By means of external relays and/or solenoids, these alarms can cause function kick out.

Alarm Settings

The three levels of alarms are programmed into the system are:

Alarm One- Amber Lamp and Pre-Alarm (Factory set at 90% of Rated Load)

Alarm Two- Internal Audible Alarm (Factory set at 90% of Rated Load)

Alarm Three- Red Lamp and Motion Cut Relay (Factory set at 100% of Rated Load)