

# MOTOR GRADERS

## CONTENTS

Industries Served .....	2-1
Features .....	2-2
Applications .....	2-7
Specifications: Standard Versions .....	2-10
Specifications: Global Versions .....	2-12
Travel Speeds .....	2-15
All Wheel Drive (AWD) .....	2-16
Mid Mount and Front Mount Scarifiers .....	2-16
Rear Ripper and Rear Ripper/Scarifier .....	2-17
Production .....	2-18
Formulas .....	2-22
Extreme Slope Operation .....	2-23
Work Tools .....	2-24

## INDUSTRIES SERVED

The motor grader is one of the most versatile work tools in the Cat® product line. The M-Series machines are used in numerous applications within a wide range of industries. The major industries using Cat motor graders, along with the typical applications within each, are summarized below.

### ● Heavy Construction

- Highway Construction
- Paving/Resurfacing
- Airport Construction
- Railroad Construction
- Dam and Levee Construction
- Haul Road Maintenance

### ● Governmental

- Road Maintenance
- Road Construction
- Ditch Building/Cleaning
- Snow Removal

### ● Building Construction

- Residential Construction
- Commercial Construction
- Industrial Construction
- Sewer and Water Systems

### ● Industrial

- Waste Disposal
- Pipeline Construction

### ● Mining

- Haul Road Maintenance
- Snow Removal

### ● Forestry

- Access Road Construction
- Forest Development
- Snow Removal
- Haul Road Maintenance

- **Geographic Versions** — Cat Motor Graders were specifically designed to meet the needs of different geographic regions and regulations. K-Series Versions for less regulated locations and M Series Global Versions are available with an assortment of standard features and optional equipment. All motor graders feature advanced electronically controlled Cat engines, power train components, hydraulics and machine structures.

**FEATURES, M-Series Motor Graders:**

Building on the strong heritage of the H-Series, the M-Series delivers multiple technological breakthroughs setting the new standard for motor graders. The H-Series has been the industry standard in a variety of heavy construction, mining, road building and governmental applications. The M-Series continues this tradition, incorporating revolutionary, customer-driven enhancements by:

- Improving ease of operation and operation training time
- Best-in-class operator station and unmatched visibility
- Maximum productivity
- Improving availability and decreasing maintenance time

The M-Series line includes seven models: 120M/120M AWD, 12M, 140M/140M AWD, 160M/160M AWD, 14M, 16M, 24M. The 120M through 14M meet construction, road building, and governmental applications. Three of the models introduce All Wheel Drive (AWD) as an option. AWD improves traction in poor underfoot conditions such as snow, mud, and sand. The 16M and 24M meet the specialized needs of large mining customers.

- **Operation Station:** The 120M through 16M models feature a revolutionary cab design that provides unmatched comfort, visibility and ease of use, making the operator more confident and productive. The M-Series provides a comfortable environment to keep the operator alert and focused. The interior noise level is maintained between 70 and 74 dB(A) with the doors and windows closed.

**Ease of Operation.** The revolutionary joystick controls and exceptional visibility make the M-Series easier to operate without sacrificing control. The intuitive joystick control pattern allows both new and experienced operators to become productive quickly. Logical grouping of hydraulic functions in the joysticks allow any operator to easily control several functions at the same time. This allows the operator to be more productive and remain comfortable throughout the work shift.

**Advanced Joystick Controls.** Two electro-hydraulic joysticks reduce hand and wrist movement as much as 78% compared to conventional lever controls for greatly enhanced operator efficiency. The intuitive pattern is easy to learn and provides the precise implement control to allow both new and experienced operators to become productive quickly. Logical grouping of hydraulic functions in the joysticks allow any operator to control several functions at the same time for more productivity.

**Visibility.** The 120M through 16M models boast excellent visibility to the work area, made possible with angled cab doors, a tapered engine enclosure and a patented sloped rear window. Ample glass area and carefully placed components provide excellent visibility to enhance operator confidence and productivity in all motor grader applications. The M-Series gives the operator an exceptional view forward to the blade, working surface and front tires. The M-Series black glare-reducing paint on the front frame and engine enclosure enhances visibility.

**Comfort and Convenience.** Caterpillar has built the most comfortable cab in the industry by replacing the control levers and steering wheel with two joystick controls, and using a deeper cab design to give more leg room.

- **Drawbar, Circle and Moldboard:** The 120M through 16M models provide a broad range of extended blade positions particularly beneficial in mid-range bank sloping, ditch cutting and ditch cleaning. A long wheel base allows for an aggressive blade angle permitting material to roll more freely, reducing power requirements. Top-accessible drawbar wear inserts and the shimless moldboard retention system make DCM adjustments fast and simple, delivering more precise material control while lowering operating costs.

**Top-Adjust Drawbar Wear Strips.** The patented top-adjust wear strips dramatically reduce drawbar/circle adjustment time. By removing the access plates on top of the drawbar, shims and wear strips can easily be added or replaced. This feature reduces service downtime and lowers overall machine operating costs.

**Shimless Moldboard Retention System.** The unique shimless moldboard retention system reduces the potential for blade chatter. Adjusting screws keep the moldboard's wear strips aligned for precise blade control and dramatic reductions in service time.

- **Power Train:** Integrated, electronically controlled systems, deliver smooth reliable performance with reduced operating costs.

**Smooth Shifting Transmission.** The M-Series combine several key innovations to ensure smooth, powerful shifts throughout the gear range.

**Electronically Controlled Shifting.** The full Electronic Clutch Pressure Control (ECPC) system optimizes inching modulation and smoothes shifting between all gears and directional changes. This provides outstanding control and also extends the life of the transmission by reducing stress on gears.

**Load Compensation.** This standard feature ensures consistent shift quality regardless of blade or machine load.

**Hydraulic Brakes.** The oil bathed, multi-disc service brakes are hydraulically actuated, providing smooth predictable braking and lower operating costs. With brakes located at each tandem wheel, the M-Series offer the largest total brake surface area in the industry, delivering dependable stopping power and longer brake life.

- **Engine:** The M-Series combine power management with ACERT™ Technology to deliver maximum power and efficiency while reducing the environmental impact.

**ACERT™ Technology.** ACERT Technology allows Cat engines to supply more power per unit of displacement without causing premature wear. This breakthrough technology reduces emissions during the combustion process by using advanced technology in the air and fuel systems, in conjunction with integrated electronics. ACERT Technology enhances overall engine performance while dramatically reducing exhaust emissions.

**Power Management.** The M-Series Power Management System automatically delivers an additional 3.7 kW (5 hp) in each forward gear 1st through 4th, and each reverse gear 1st through 3rd. This standard feature optimizes rimpull for all gears by balancing traction, speed and horsepower while conserving fuel. The system limits horsepower in lower gears, which helps reduce wheel slip where traction is limited. With the Variable Horsepower Plus (VHP Plus) option, an additional 3.7 kW (5 hp) is delivered in each forward gear 5th through 8th for more power at higher speeds.

**Exhaust Emissions Compliant.** The Cat ACERT Technology engines meet or exceed all U.S. EPA Tier 3 and European Union Stage IIIa emissions control standards.

- **Hydraulics:** The M-Series electro-hydraulics enable advanced machine controls with precise and predictable movements.

**Advanced Electro-Hydraulic System.** The M-Series incorporates a state-of-the-art electro-hydraulic system. This technology is the foundation for revolutionary changes of the machine and implement controls. Advanced joystick controls provide unmatched controllability with precise and predictable hydraulic movements, and the reliability you expect from Caterpillar.

**Load Sensing Hydraulics (PPPC).** The time proven load-sensing system and the advanced Proportional Priority Pressure-Compensating (PPPC, or “triple-PC”) electro-hydraulic valves on the M-Series are designed to provide superior implement control and enhanced machine performance in all applications. Continuous matching of hydraulic flow and pressure to power demands creates less heat and reduces power consumption.

- **Integrated Electronic Solutions:** Full systems integration optimizes machine performance and availability.

**“Smart Machine.”** The M-Series fully integrate all core systems creating a “Smart Machine.” The Cat data link shares key data among systems, optimizing machine performance while preventing potential machine damage.

**AccuGrade™ Attachment Ready Option.** The AccuGrade Attachment Ready Option is fully integrated into the machine design, making installation quick and easy. Integral hydraulic and electrical components are standard on M-Series (Grade Control Ready). The AccuGrade Attachment Ready Option provides additional mounting brackets, cab controls and electrical harnesses for easy installation of the Cross Slope, Sonic, Laser, GPS or ATS electronics kits.

- **Serviceability:**

**Grouped Service Points.** The M-Series group daily service points in the left side service center to help ensure proper maintenance and inspection routines.

**Extended Service Intervals.** The M-Series extended service intervals, such as 500-hour engine oil changes and 4000-hour hydraulic oil changes, reduce machine service time and increase availability.

**Ecology Drains.** Conveniently located ecology drains shorten service times and help keep the environment safe by preventing spills.

**Diagnostics and Monitoring.** The M-Series provides Cat Messenger as standard equipment to enhance diagnostic capabilities by displaying machine system errors and fault codes. Cat Electronic Technician is a two way communication tool that provides easy access to stored diagnostic data and lets technicians configure machine parameters through the Cat Data Link. The optional Product Link provides a communication flow of vital machine data and location. The M-Series integrates Cat Messenger, Cat Electronic Technician, and S-O-S<sup>SM</sup> analysis for easy monitoring and fast troubleshooting, keeping your machine up and running.

- **Safety.** Safety is an integral part of all machine and system designs. The M-Series machines provide a safe working environment for both the operator and ground personnel. ROPS and FOPS structures meeting current SAE and ISO requirements are standard on all Global machines. Backup alarms are also standard on the M Series.

**Operator Presence System.** The Operator Presence System keeps the parking brake engaged until the operator is seated for safe operation.

**Secondary Steering System.** The standard secondary steering system automatically engages in case of a drop in steering pressure, allowing the operator to steer the machine to a stop.

**Speed Sensitive Steering.** The steering software automatically provides an infinitely variable ratio between the joystick and the steer tires, resulting in less sensitive steering as the ground-speed increases.

**Hydraulic Lockout.** A simple switch located in the cab disables all implement functions while still providing machine steering control. This safety feature is especially useful while the machine is roading.

**Circle Drive Slip Clutch.** This standard feature protects the drawbar, circle and moldboard from shock loads when the end of the blade encounters immovable objects. It also reduces the possibility of abrupt directional changes in poor traction conditions, protecting the machine, operator and surroundings.

**Blade Lift Accumulators.** This optional feature uses accumulators to help absorb impact loads to the moldboard by allowing vertical blade travel. Blade lift accumulators reduce unnecessary wear and help to avoid unintended machine movement for increased operator safety.

**Drop-Down Rear Lights.** Optional drop down lights fold out from the rear of the machine. This creates a wider, lower profile, to be better aligned with passenger cars.

**Rear View Camera.** Visibility is further enhanced with an optional Work Area Vision System (WAVS) LCD color monitor in the cab.

- **Best Product Support:** Cat motor grader users are assured the best product support anywhere in the world. With industry-best parts availability, training and an offering of inspection, maintenance and repair, Cat dealers can provide the support needed to keep the machines productive.

## FEATURES, K-Series Motor Graders:

### Overview

The K-Series model line-up is targeted to meet customer requirements in less regulated countries. Built on the success of the Standard H-Series, the K-Series delivers multiple improvements in emissions control and operator features, while still maintaining the industry standard for reliability. The K-Series model line-up consists of the 120K, 12K, 140K and 160K.

### Engine

- **ACERT Engine Technology:** The K-Series models are equipped with Caterpillar ACERT engine technology, which uses numerous advanced components to efficiently produce more power and fewer emissions.
- **Emissions Compliant:** The K-Series machines meet or exceed US EPA Tier 2 and EU Stage II emissions regulations.
- **Power Management Strategy:** The K-Series power management strategy provides an additional 7.5 kW (10 hp) increase in third and another 7.5 kW (10 hp) in fourth gear through Variable Horsepower (VHP). This allows the operator to maintain maximum rimpull while increasing ground speed and productivity.

### Power Train

- **Electronic Clutch Pressure Control (ECPC):** This standard K-Series feature smoothes shifts and improves inching control. The system uses input from the transmission and operator controls to modulate the directional clutches and produce consistent shifting.
- **Autoshift:** This optional feature improves ease of operation and maximizes productivity by automatically shifting the transmission at optimal shifting points.

### Serviceability

- **Grouped Service Points:** The K-Series group daily service points in the left side service center to help ensure proper maintenance and inspection routines.
- **Diagnostic Capability:** The K-Series offer an improved dash cluster to keep the operator informed of critical system conditions. Cat Electronic Technician is also offered and this allows faster diagnostic capabilities by service personnel. Product Link allows tracking of vital machine data and location providing a convenient way to track the machine.
- **Extended Service Intervals:** Improvements in serviceability allow increased machine operation between service intervals. The machines can operate a full 500 hours between engine oil and filter changes, 4,000 hours between hydraulic oil changes, and 12,000 hours between engine coolant changes. This reduces downtime and operating expense.

## **APPLICATIONS, Motor Graders:**

The broad line of Cat motor graders allows the customer to choose a motor grader that best fits the intended application. Below is a summary of the typical motor grader applications.

### **Finish Grading**

This application involves preparing a roadway or site surface for future paving or other construction activity. The material being moved is usually a hard, dry base material on a solid underfoot. Finish blading is the motor grader application that requires the highest degree of accuracy. Thus, it is primarily done at low operating speeds — usually less than 5 km/h (3 mph) — in gears 1 and 2. To ensure a smooth, even finished surface, one gear is usually maintained for a given pass. Pass lengths during this application are usually less than 600 m (2000 feet) for road construction and 150 m (500 feet) for site development. Most finish blading is performed by contractors in the Heavy Construction and Building Construction industries.

### **Heavy Blading**

This application involves cutting, moving, and mixing material, usually in the initial stages of surface preparation. A variety of material types are moved in this manner, and the blade tip position varies accordingly. Full blade loads are usually experienced during heavy blading, since moving material is the primary goal. Pass lengths within this application vary, but are usually less than 600 m (2000 feet). Unlike with finish blading, the speed of the machine is dependent on the load being moved when heavy blading material. Typical operating speeds are from 0-10 km/h (0 to 6 mph). Therefore, gears 2 through 4 are frequently used in this application. Most heavy blading activity is performed by contractors in the Heavy Construction, Governmental, Industrial, and Forestry industries.

### **Site Preparation**

This application involves any material cutting, moving, and mixing necessary to prepare a residential, commercial, or industrial site for construction. A variety of materials are encountered in this application. Blade loads vary depending on the activity being performed. Both heavy blading and finish blading are performed when preparing a site. Pass lengths are typically in the range of 30-300 m (100 to 1000 feet). Typical operating speeds for site preparation vary depending on whether heavy blading or finish blading activities are being performed. Most site preparation activities are performed by contractors in the Building Construction industry.

### **Road Maintenance**

This application involves reshaping dirt or gravel roads to maintain a crown or superelevation, or restoring the surface itself. This generally involves secondary roads maintained by governmental bodies such as townships and counties. Materials being moved in this application vary from extremely hard dirt bases to moist gravel surfaces. The typical blade load falls between that of finish blading and heavy blading. Pass lengths are frequently longer than 600 m (2000 feet), and can extend for miles. The general speed range for this application is 5-16 km/h (3 to 10 mph), corresponding to gears 2 (heavy dirt) through 5 (soft gravel). As with finish blading, accuracy of the graded surface is the primary concern in this application. Thus, frequent shifts should be avoided whenever possible. A gear should be chosen and maintained unless there is a significant change in the material being moved. Most road maintenance activities are performed by the Governmental industry.

### Haul Road Maintenance

This application of the motor grader involves reshaping haul roads at mining, construction, or forestry work sites, usually for the purpose of maintaining smooth travel surfaces for equipment. Materials being moved while maintaining haul roads vary widely depending on the application. Typical blade loads are about one-third to half of full capacity. Some haul roads that experience large hauling units travelling on soft material may require heavy blade loads in order to reshape the road surface. Pass lengths vary depending on the application, but can extend for miles on remote forestry or large mine haul roads. The general speed range for haul road maintenance is heavily dependent on the material being moved as well as the grade of the haul road. Many mine sites are in mountainous areas, requiring haul roads with steep grades. Generally, haulroad maintenance is performed at speeds similar to those required for general road maintenance 5-16 km/h (3 to 10 mph).

A travel surface that allows for the safe and efficient movement of machinery is the ultimate goal with this motor grader application. Very precise roadway elevations and slopes are desired, but are not as crucial as they are when finish blading. Most haul road maintenance activities are performed by the Mining, Heavy Construction, and Forestry industries.

### Side/Bank Slope Work

This application involves preparing side slopes or bank slopes along roadways by placing the moldboard on a sloped surface. Slopes of up to a 2:1 angle can be cut using a motor grader. Often the motor grader is operated on the level surface adjacent to the slope, and the moldboard is extended outward to the sloped surface. Fine soils are generally encountered in this application of the motor grader. Blade loads are usually less than half of the full-blade capacity, and pass lengths are seldom longer than 600 m (2000 feet). A smooth-graded sloped surface is the primary concern in this application, so frequent shifts should be avoided. The typical speed range is 0-6 km/h (0 to 4 mph), corresponding to a gear selection of 1 to 3. The nominal speed is heavily dependent on the type of material being moved and on the slope of the surface. Most side/bank slope work is performed by the Heavy Construction and Governmental industries.

### Ditch Building/Cleaning

This application involves cutting “V” and flat-bottom ditches for drainage purposes and rebuilding them when necessary. Due to excessive rain and/or poor material, ditches often need cleaning and reshaping. When building ditches, materials with a wide range of densities are encountered. Blade loads vary accordingly, from half to full-blade capacity. Pass lengths are usually less than 600 m (2000 feet). The primary objective is to move material in a manner that yields a ditch with the desired slope. Ditch building often involves cutting and moving material of high density. Therefore, typical speed ranges vary. Most ditch-building work, however, is performed in gears 1 through 3, corresponding to a maximum speed of about 8 km/h (5 mph). Ditch cleaning usually involves blading moist materials underneath a sod cover. Blade loads are usually less than half of full blade capacity when cleaning ditches, and pass lengths are similar to those encountered in ditch building. Typical maximum speeds for this activity are similar to that of ditch building, but less of a blade load is experienced. Ditch building and cleaning activities are usually performed by the Heavy Construction and Governmental industries.

### Ripping/Scarifying

This application involves conditioning hard, rough soils before they are bladed. Shanks on the ripper and/or scarifier are pushed into the ground, thus breaking up otherwise hard surfaces. Hard materials such as asphalt can also be loosened in order to make grading operations less damaging to the moldboard. Rippers and scarifiers can also be used to mix aggregates together. The materials being ripped/scarified are usually hard and dry. Rippers generally penetrate 150-300 mm (6 to 12 inches) into the ground, while scarifiers typically penetrate to a depth of 25-200 mm (1 to 8 inches). Pass lengths are generally less than 600 m (2000 feet) for both activities. Since the material being ripped/scarified is generally hard, the typical maximum speed for this application is about 6 km/h (4 mph) gears 1-2. If the ripper/scarifier is used for mixing aggregates, the typical operating range becomes 6-20 km/h (4 to 12 mph) gears 3-6. Most ripping/scarifying activities are performed by the Heavy Construction and Governmental industries.

### Snow Removal

Snow removal is the process of cutting and removing snow or ice from the roadway. In addition to the standard motor grader moldboard, other attachments such as a snow wing, V-plow, one-way plow, or reversible plow can be used to remove the snow. The moldboard itself is the most commonly used attachment for snow plowing. It is used in areas where snow depths are low, the terrain is relatively flat, and where excessive drifting does not occur. A snow wing is a moldboard that attaches to the machine's right side. The wing's curvature lifts the snow and "wings" it off the plowed surface. The snow wing is often used in conjunction with the standard moldboard, where the moldboard cuts the material and feeds it onto the wing. V-plows are mounted in front of the motor grader and are designed to dig into and lift packed snow. The typical speed range for snow removal is 10-30 km/h (6 to 18 mph), corresponding to a gear range of 3 to 7. Snow plowing often involves lower speeds than snow removal. The typical operating range for snow plowing is 8-19 km/h (5 to 12 mph) gears 2 to 4. The majority of Snow Removal/Plowing operations are performed by the Governmental, Mining, and Forestry industries.

# Motor Graders Standard Versions

## Specifications



MODEL	120K		12K	
Net Flywheel Power: Gears 4-8	108 kW	145 hp	123 kW	165 hp
Gear 3▲	101 kW	135 hp	116 kW	155 hp
Gears 1-2▲	93 kW	125 hp	108 kW	145 hp
Operating Weight (Typical)*	13 032 kg	28,731 lb	14 334 kg	31,601 lb
Engine Model	C7 ACERT™ VHP		C7 ACERT VHP	
Rated Engine RPM	2000		2000	
No. of Cylinders	6		6	
Displacement	7.2 L	439 in <sup>3</sup>	7.2 L	439 in <sup>3</sup>
Max. Torque	50%		50%	
No. of Speeds Forward/Reverse	8/6		8/6	
Top Speed: Forward	45.7 km/h	28.4 mph	44.8 km/h	27.9 mph
Reverse	36.1 km/h	22.4 mph	35.4 km/h	22 mph
Std. Tires — Front and Rear	13.00-24 (12 PR) (G-2)		13.00-24 (12 PR) (G-2)	
Front Axle/Steering:				
Oscillation Angle	32°		32°	
Wheel Lean Angle	18°		18°	
Steering Angle	47.5°		47.5°	
Articulation Angle	20°		20°	
Minimum Turning Radius**	7.3 m	23'10"	7.5 m	24'7"
Front Frame Section Modulus:				
Min.	1619 cm <sup>2</sup>	99 in <sup>2</sup>	2083 cm <sup>2</sup>	127 in <sup>2</sup>
Max.	3681 cm <sup>2</sup>	225 in <sup>2</sup>	4785 cm <sup>2</sup>	291 in <sup>2</sup>
No. Circle Support Shoes	4		6	
Hydraulics: Pump Type	Variable Piston		Variable Piston	
Max. Pump Flow	205.8 L/min	54.4 gpm	205.8 L/min	54.4 gpm
Reservoir Tank Capacity	55 L	14.5 U.S. gal	55 L	14.5 U.S. gal
Implement Pressure: Max.	25 500 kPa	3699 psi	25 500 kPa	3699 psi
Min.	3600 kPa	522 psi	3600 kPa	522 psi
Electrical:				
System Size	24V		24V	
Std. Battery CCA @ 0° F	750		750	
Std. Alternator	95 amp		95 amp	
GENERAL DIMENSIONS:				
Height (to top of ROPS)	3.33 m	10'11"	3.32 m	10'11"
Height (No Cab/Canopy)***	2.88 m	9'6"	3.02 m	9'11"
Overall Length	8.24 m	27'0"	8.47 m	27'9"
With Ripper and Pushplate	9.77 m	32'1"	10.01 m	32'10"
Wheelbase	5.87 m	19'3"	6.09 m	20'0"
Blade Base	2.60 m	8'6"	2.60 m	8'6"
Overall Width (at top of front tires)	2.46 m	8'1"	2.46 m	8'1"
Standard Blade: Length	3.66 m	12'0"	3.66 m	12'0"
Height	610 mm	2'0"	610 mm	2'0"
Thickness	22 mm	0.87"	22 mm	0.87"
Lift Above Ground	410 mm	16"	480 mm	19"
Max. Shoulder Reach:◀				
Frame Straight — right	1.93 m	6'4"	1.81 m	5'11"
Frame Straight — left	1.76 m	5'9"	1.86 m	6'1"
Fuel Tank Capacity	305 L	80.6 U.S. gal	305 L	80.6 U.S. gal

\*Typical Operating Weight — based on standard machine configuration, with Cab High Profile ROPS, 13.00-24 12 PR (G-2) tires, full fuel tank, coolant, lubricants and operator.

\*\*Minimum Turning Radius — combining the use of articulated frame steering, front wheel steer and unlocked differential.

\*\*\*Height (No Cab/Canopy) — without ROPS, exhaust, or other easily removed encumbrances.

◀ Applicable for the standard blade with hydraulic sideshift and tip control. Maximum shoulder reach is obtainable to the right.

▲ Engine Power Management automatically reduces power in gears 1F-3F and 1R-2R.



MODEL	140K		160K	
Net Flywheel Power: Gears 4-8	142 kW	190 hp	154 kW	206 hp
Gear 3▲	135 kW	181 hp	147 kW	196 hp
Gears 1-2▲	127 kW	170 hp	139 kW	186 hp
Operating Weight (Typical)*	14 768 kg	32,558 lb	15 785 kg	34,800 lb
Engine Model	C7 ACERT VHP		C7 ACERT VHP	
Rated Engine RPM	2000		2000	
No. of Cylinders	6		6	
Displacement	7.2 L	439 in <sup>3</sup>	7.2 L	439 in <sup>3</sup>
Max. Torque	46%		46%	
No. of Speeds Forward/Reverse	8/6		8/6	
Top Speed: Forward	46.8 km/h	29.1 mph	46.4 km/h	28.8 mph
Reverse	37 km/h	23 mph	36.6 km/h	22.8 mph
Std. Tires — Front and Rear	14.00-24 (12 PR) (G-2)		14.00-24 (12 PR) (G-2)	
Front Axle/Steering:				
Oscillation Angle	32°		32°	
Wheel Lean Angle	18°		18°	
Steering Angle	47.5°		47.5°	
Articulation Angle	20°		20°	
Minimum Turning Radius**	7.5 m	24'7"	7.5 m	24'7"
Front Frame Section Modulus:				
Min.	2083 cm <sup>2</sup>	127 in <sup>2</sup>	2083 cm <sup>2</sup>	127 in <sup>2</sup>
Max.	4785 cm <sup>2</sup>	291 in <sup>2</sup>	4785 cm <sup>2</sup>	291 in <sup>2</sup>
No. Circle Support Shoes	6		6	
Hydraulics: Pump Type	Variable Piston		Variable Piston	
Max. Pump Flow	205.8 L/min	54.4 gpm	205.8 L/min	54.4 gpm
Reservoir Tank Capacity	55 L	14.5 U.S. gal	55 L	14.5 U.S. gal
Implement Pressure: Max.	25 500 kPa	3699 psi	25 500 kPa	3699 psi
Min.	3600 kPa	522 psi	3600 kPa	522 psi
Electrical:				
System Size	24V		24V	
Std. Battery CCA @ 0° F	750		750	
Std. Alternator	95 amp		95 amp	
GENERAL DIMENSIONS:				
Height (to top of ROPS)	3.35 m	11'0"	3.35 m	11'0"
Height (No Cab/Canopy)***	3.05 m	10'0"	3.05 m	10'0"
Overall Length	8.50 m	27'11"	8.50 m	27'11"
With Ripper and Pushplate	10.01 m	32'10"	10.01 m	32'10"
Wheelbase	6.09 m	20'0"	6.09 m	20'0"
Blade Base	2.60 m	8'6"	2.55 m	8'4"
Overall Width (at top of front tires)	2.48 m	8'2"	2.48 m	8'2"
Standard Blade: Length	3.66 m	12'0"	4.27 m	14'0"
Height	610 mm	2'0"	686 mm	2'3"
Thickness	22 mm	0.87"	25 mm	1"
Lift Above Ground	480 mm	18.9"	452 mm	17.8"
Max. Shoulder Reach:◀				
Frame Straight — right	1.98 m	6'6"	2.26 m	7'5"
Frame Straight — left	1.90 m	6'3"	2.22 m	7'4"
Fuel Tank Capacity	305 L	80.6 U.S. gal	344 L	90.9 U.S. gal

\*Typical Operating Weight — based on standard machine configuration, with Cab High Profile ROPS, 14.00-24 12 PR (G-2) tires, full fuel tank, coolant, lubricants and operator.

\*\*Minimum Turning Radius — combining the use of articulated frame steering, front wheel steer and unlocked differential.

\*\*\*Height (No Cab/Canopy) — without ROPS, exhaust, or other easily removed encumbrances.

◀Applicable for the standard blade with hydraulic sideshift and tip control. Maximum shoulder reach is obtainable to the right.

▲Engine Power Management automatically reduces power in gears 1F-3F and 1R-2R.



MODEL	120M		12M	
Base Power — Net	103 kW	138 hp	118 kW	158 hp
VHP Range — Net	103-114 kW	138-153 hp	118-129 kW	158-173 hp
VHP Plus Range — Net	103-129 kW	138-173 hp	118-144 kW	158-193 hp
Operating Weight*	14 093 kg	31,069 lb	14 522 kg	32,016 lb
Engine Model	C6.6 ACERT VHP		C6.6 ACERT VHP	
Rated Engine RPM	2000		2000	
No. of Cylinders	6		6	
Displacement	6.6 L	403 in <sup>3</sup>	6.6 L	403 in <sup>3</sup>
Max. Torque	859 N·m	690 lb·ft	859 N·m	690 lb·ft
No. of Speeds Forward/Reverse	8/6		8/6	
Top Speed: Forward	44.5 km/h	27.7 mph	44.5 km/h	27.7 mph
Reverse	37.8 km/h	23.5 mph	37.8 km/h	23.5 mph
Std. Tires — Front and Rear	13.00 24 (12 PR) (G-2)		13.00 24 (12 PR) (G-2)	
Front Axle/Steering:				
Oscillation Angle	32°		32°	
Wheel Lean Angle	18.0°		18.0°	
Steering Angle	47.5°		47.5°	
Articulation Angle	20°		20°	
Minimum Turning Radius**	7.5 m	24'6"	7.5 m	24'6"
No. Circle Support Shoes	4		6	
Hydraulics:				
Pump Type	Variable Piston		Variable Piston	
Max. Pump Flow	151 L/min	40 gpm	193 L/min	51 gpm
Tank Capacity	60 L	15.9 U.S. gal	60 L	15.9 U.S. gal
Implement Pressure: Max.	24 150 kPa	3500 psi	24 150 kPa	3500 psi
Min.	3100 kPa	450 psi	3100 kPa	450 psi
Interior Sound Level/SAE J919	70 dB(A)		70 dB(A)	
Electrical:				
System Size	24V		24V	
Std. Battery CCA @ 0° F	880		880	
Std. Alternator	80		80	
GENERAL DIMENSIONS:				
Height (to top of ROPS)	3278 mm	129"	3278 mm	129"
Overall Length	8488 mm	334"	8488 mm	334"
With Ripper and Pushplate	9889 mm	389"	9889 mm	389"
Wheelbase	5915 mm	233"	5915 mm	233"
Blade Base	2511 mm	99"	2511 mm	99"
Overall Width (at top of front tires)	2481 mm	98"	2481 mm	98"
Standard Blade: Length	3658 mm	12'0"	3658 mm	12'0"
Height	610 mm	24"	610 mm	24"
Thickness	22 mm	0.87"	22 mm	0.87"
Lift Above Ground	427 mm	16.8"	427 mm	16.8"
Max. Shoulder Reach:***				
Frame Straight — left	1742 mm	68.6"	1742 mm	68.6"
Frame Straight — right	1905 mm	75"	1905 mm	75"
Fuel Tank Capacity	340 L	90 U.S. gal	340 L	90 U.S. gal

\*Operating Weight — based on standard machine configuration with full fuel tank, coolant, lubricants and operator.

\*\*Minimum Turning Radius — combining the use of articulated frame steering, front wheel steer and unlocked differential.

\*\*\*Applicable for the standard blade with hydraulic sideshift and tip control. Maximum shoulder reach is obtainable to the right.



140M



160M

## MODEL

	140M		160M	
Base Power — Net	136 kW	183 hp	159 kW	213 hp
VHP Range — Net	136-148 kW	183-198 hp	159-170 kW	213-228 hp
VHP Plus Range — Net	136-163 kW	183-218 hp	159-185 kW	213-248 hp
Operating Weight*	15 130 kg	33,356 lb	15 903 kg	35,060 lb
Engine Model	C7 ACERT VHP		C9 ACERT VHP	
Rated Engine RPM	2000		2000	
No. of Cylinders	6		6	
Displacement	7.2 L	439 in <sup>3</sup>	8.8 L	537 in <sup>3</sup>
Max. Torque	1079 N·m	796 lb·ft	1237 N·m	912 lb·ft
No. of Speeds Forward/Reverse	8/6		8/6	
Top Speed: Forward	46.6 km/h	29 mph	47.4 km/h	29.5 mph
Reverse	36.8 km/h	22.9 mph	37.4 km/h	23.3 mph
Std. Tires — Front and Rear	14.00 24 (10 PR) (G-2)		14.00 24 (10 PR) (G-2)	
Front Axle/Steering:				
Oscillation Angle	32°		32°	
Wheel Lean Angle	18.0°		18.0°	
Steering Angle	47.5°		47.5°	
Articulation Angle	20°		20°	
Minimum Turning Radius**	7.75 m	25'6"	7.75 m	25'6"
No. Circle Support Shoes	6		6	
Hydraulics:				
Pump Type	Variable Piston		Variable Piston	
Max. Pump Flow	210 L/min	55.7 gpm	210 L/min	55.7 gpm
Tank Capacity	60 L	15.9 U.S. gal	60 L	15.9 U.S. gal
Implement Pressure: Max.	24 150 kPa	3500 psi	24 150 kPa	3500 psi
Min.	3100 kPa	450 psi	3100 kPa	450 psi
Interior Sound Level/SAE J919	70 dB(A)		70 dB(A)	
Electrical:				
System Size	24V		24V	
Std. Battery CCA @ 0° F	880		880	
Std. Alternator	80		80	
GENERAL DIMENSIONS:				
Height (to top of ROPS)	3293 mm	130"	3293 mm	130"
Overall Length	8713 mm	343"	8713 mm	343"
With Ripper and Pushplate	10 144 mm	399"	10 144 mm	399"
Wheelbase	6121 mm	241"	6121 mm	241"
Blade Base	2552 mm	101"	2552 mm	101"
Overall Width (at top of front tires)	2493 mm	98"	2493 mm	98"
Standard Blade: Length	3658 mm	12'0"	3658 mm	12'0"
Height	610 mm	24"	610 mm	24"
Thickness	22 mm	0.87"	22 mm	0.87"
Lift Above Ground	480 mm	18.9"	452 mm	17.8"
Max. Shoulder Reach:***				
Frame Straight — left	1790 mm	70.5"	2090 mm	82.3"
Frame Straight — right	1978 mm	77.9"	2278 mm	89.7"
Fuel Tank Capacity	416 L	110 U.S. gal	416 L	110 U.S. gal

\*Operating Weight — based on standard machine configuration with full fuel tank, coolant, lubricants and operator.

\*\*Minimum Turning Radius — combining the use of articulated frame steering, front wheel steer and unlocked differential.

\*\*\*Applicable for the standard blade with hydraulic sideshift and tip control. Maximum shoulder reach is obtainable to the right.

# Motor Graders Global Versions

## Specifications



MODEL	14M		16M		24M	
Base Power — Net	193 kW	259 hp	221 kW	297 hp	397 kW	533 hp
VHP Range — Net	193-204 kW	259-274 hp	221-233 kW	297-312 hp	—	—
VHP Plus Range — Net	193-219 kW	259-294 hp	221-248 kW	297-332 hp	—	—
Operating Weight*	21 379 kg	47,133 lb	26 060 kg	57,452 lb	62 456 kg	137,692 lb
Engine Model	C11		C13 ACERT VHP		C18 ACERT	
Rated Engine RPM	1800		2000		1800	
No. of Cylinders	6		6		6	
Displacement	11.1 L	677 in <sup>3</sup>	12.5 L	763 in <sup>3</sup>	18.1 L	1104.5 in <sup>3</sup>
Max. Torque	1422 N·m	1049 lb·ft	1710 N·m	1261 lb·ft	2389 N·m	1762 lb·ft
No. of Speeds Forward/Reverse	8/6		8/6		6/3	
Top Speed: Forward	49.8 km/h	31 mph	53.9 km/h	33.5 mph	43 km/h	26.7 mph
Reverse	39.4 km/h	24.5 mph	42.6 km/h	26.5 mph	41.2 km/h	25.6 mph
Std. Tires — Front and Rear	16.00-24 (16 PR) (G-2)		18.00-25 (12 PR) (G-2)		—	
Front Axle/Steering:						
Oscillation Angle	32°		32°		32°	
Wheel Lean Angle	17.1°		18.2°		18.0°	
Steering Angle	47.5°		47.5°		47.5°	
Articulation Angle	20°		20°		20°	
Minimum Turning Radius**	7.9 m	25'11"	8.9 m	29'3"	12.4 m	40'9"
No. Circle Support Shoes	6		6		6	
Hydraulics:						
Pump Type	Variable Piston		Variable Piston		Variable Piston	
Max. Pump Flow	280 L/min	74 gpm	280 L/min	74 gpm	550 L/min	145 gpm
Tank Capacity	60 L	15.9 U.S. gal	60 L	15.9 U.S. gal	264 L	70 U.S. gal
Implement Pressure: Max.	24 150 kPa	3500 psi	24 150 kPa	3500 psi	24 150 kPa	3500 psi
Min.	3100 kPa	450 psi	3100 kPa	450 psi	3100 kPa	450 psi
Interior Sound Level/SAE J919	70 dB(A)		72 dB(A)		74 dB(A)	
Electrical:						
System Size	24V		24V		24V	
Std. Battery CCA @ 0° F	1125		1400		1500	
Std. Alternator	80		150		150	
GENERAL DIMENSIONS:						
Height (to top of ROPS)	3535 mm	139.2"	3703 mm	145.8"	4352 mm	171.3"
Overall Length	9412 mm	370.6"	9963 mm	392.2"	14 194 mm	558.8"
With Ripper and Pushplate	10 896 mm	429"	11 672 mm	459.5"	16 102 mm	633.9"
Wheelbase	6559 mm	258"	6985 mm	275"	10 278 mm	404.6"
Blade Base	2842 mm	112"	3069 mm	120.8"	4048 mm	159.4"
Overall Width (at top of front tires)	2791 mm	109.9"	3096 mm	121.9"	4280 mm	168.5"
Standard Blade: Length	4287 mm	14'0"	4877 mm	16'0"	7315 mm	24'0"
Height	686 mm	27"	787 mm	31"	1076 mm	42"
Thickness	25 mm	1"	25 mm	1"	50 mm	2"
Lift Above Ground	419 mm	16.5"	395 mm	15.6"	634 mm	25"
Max. Shoulder Reach:***						
Frame Straight — left	2169 mm	85.4"	2282 mm	90"	3222 mm	126.9"
Frame Straight — right	2279 mm	89.7"	2587 mm	101.9"	3228 mm	127.1"
Fuel Tank Capacity	492 L	130 U.S. gal	511 L	135 U.S. gal	1326 L	350 U.S. gal

\*Operating Weight — based on standard machine configuration with full fuel tank, coolant, lubricants and operator. 24M includes ripper.

\*\*Minimum Turning Radius — combining the use of articulated frame steering, front wheel steer and unlocked differential.

\*\*\*Applicable for the standard blade with hydraulic sideshift and tip control. Maximum shoulder reach is obtainable to the right.

**TRAVEL SPEEDS @ RATED RPM WITH STD. TIRES (M SERIES GLOBAL VERSION)**

Gear		1		2		3		4		5		6		7		8	
		km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph
120M	Forward	3.9	2.4	5.3	3.3	7.6	4.75	10.5	6.5	16.4	10.2	22.2	13.8	30.6	19.0	44.5	27.7
	Reverse	3.3	2.0	6.2	3.8	8.9	5.6	13.9	8.6	26.0	16.1	37.8	23.5	—	—	—	—
12M	Forward	3.9	2.4	5.3	3.3	7.6	4.75	10.5	6.5	16.4	10.2	22.2	13.8	30.6	19.0	44.5	27.7
	Reverse	3.3	2.0	6.2	3.8	8.9	5.6	13.9	8.6	26.0	16.1	37.8	23.5	—	—	—	—
140M	Forward	4	2.5	5.5	3.4	8.0	5.0	11.0	6.8	17.1	10.6	23.3	14.5	32.0	19.9	46.6	29.0
	Reverse	3.2	2.0	6.0	3.7	8.7	5.4	13.5	8.4	25.3	15.7	36.8	22.9	—	—	—	—
160M	Forward	4.1	2.5	5.6	3.5	8.1	5.0	11.2	7.0	17.4	10.8	23.7	14.7	32.6	20.3	47.4	29.5
	Reverse	3.3	2.0	6.1	3.8	8.8	5.5	13.7	8.5	25.7	16.0	37.4	23.3	—	—	—	—
14M	Forward	4.3	2.7	5.9	3.7	8.6	5.3	11.8	7.3	18.3	11.4	24.8	15.4	34.2	21.3	49.8	31.0
	Reverse	3.4	2.1	6.4	4.0	9.3	5.8	14.5	9.0	27.1	16.9	39.4	24.5	—	—	—	—
16M	Forward	4.5	2.8	6.3	3.9	9.0	5.6	12.4	7.7	19.3	12.0	26.8	16.7	37.0	23.0	53.9	33.5
	Reverse	3.6	2.2	6.8	4.2	9.8	6.1	15.2	9.5	29.3	18.2	42.6	26.5	—	—	—	—
24M	Forward	3.6	2.3	5.7	3.5	9.6	6.0	15.0	9.3	27.7	17.2	43.0	26.7	—	—	—	—
	Reverse	5.4	3.4	14.3	8.9	41.2	25.6	—	—	—	—	—	—	—	—	—	—

**TRAVEL SPEEDS @ RATED RPM WITH STD. TIRES (STANDARD VERSION)**

Gear		1		2		3		4		5		6		7		8	
		km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph	km/h	mph
120K	Forward	3.9	2.4	5.3	3.3	7.7	4.8	10.7	6.6	16.8	10.4	22.8	14.2	31.4	19.5	45.7	28.4
	Reverse	3.1	1.9	5.8	3.6	8.4	5.2	13.3	8.2	24.8	15.4	36.1	22.4	—	—	—	—
12K	Forward	3.8	2.4	5.2	3.2	7.6	4.7	10.4	6.5	16.5	10.2	22.4	13.9	30.8	19.2	44.8	27.9
	Reverse	3.0	1.9	5.7	3.5	8.2	5.1	13.0	8.1	24.3	15.1	35.4	22.0	—	—	—	—
140K	Forward	4.0	2.5	5.4	3.4	7.9	4.9	10.9	6.8	17.2	10.7	23.4	14.5	32.2	20.0	46.8	29.1
	Reverse	3.2	2.0	5.9	3.7	8.6	5.3	13.6	8.4	25.4	15.8	37.0	23.0	—	—	—	—
160K	Forward	4.1	2.5	5.5	3.4	8.0	4.9	11.0	6.8	17.0	10.6	23.2	14.4	31.9	19.8	46.4	28.8
	Reverse	3.2	2.0	5.9	3.7	8.7	5.4	13.4	8.4	25.2	15.6	36.6	22.8	—	—	—	—

## Motor Graders

- All Wheel Drive
- Mid Mount and Front Mount Scarifiers

### ALL WHEEL DRIVE (AWD) OPTIONAL ON THREE MODELS

**120M, 140M, 160M**

Working Range:	
Forward Gears	<b>gears 1-7</b>
Reverse Gears	<b>gears 1-5</b>
Pump Type	<b>Variable Displacement Axial Piston Pumps (2)</b>
Motor Type	<b>Variable Displacement Axial Piston Motors (2)</b>
Front Wheel Gear Reduction	<b>Double Planetary Reduction</b>
Maximum Pump Flow (each pump)	125 L/min <b>33 gpm</b>
Front Wheel Torque	13 998 N·m <b>10,325 lb-ft</b>
Control Type	<b>Speed control with closed-loop feedback</b>

The optional AWD system utilizes dedicated left and right pumps for precise hydraulic control.

Gross power is automatically increased up to 26 kW (**35 hp**) with AWD engaged, maintaining a constant net power to the ground.

Hydrostatic Mode disengages the transmission and provides hydraulic power to the front wheels only-ininitely variable to 8 km/h (**5 mph**).

Exclusive AWD Steering Compensation adjusts outside front tire speed up to 50% faster than the inside tire.

Operating Pressure depends on engine speed, gear selection and operating conditions.

### M10 — MID MOUNT SCARIFIER

**120M, 12M, 140M, 160M**

Type	V type		Straight type*	
Working Width	1184 mm	<b>46.6"</b>	1800 mm	<b>71"</b>
Depth (Max.)	292 mm	<b>11.5"</b>	317 mm	<b>12.5"</b>
Number of Shank Holders		<b>11</b>		<b>17</b>
Spacing	116 mm	<b>4.6"</b>	111 mm	<b>4.38"</b>

\*Available on M Series Global Versions only.

### FRONT MOUNT SCARIFIER

**120M, 12M, 140M, 160M**

Type	V type	
Working Width	1205 mm	<b>47.4"</b>
Depth (Max.)	467 mm	<b>18.4"</b>
Number of Shank Holders		<b>11</b>
Spacing	116 mm	<b>4.6"</b>

<b>MOTOR GRADER/ RIPPER</b>	<b>120M</b>		<b>12M/140M/160M</b>		<b>14M</b>		<b>16M</b>		<b>24M</b>	
<b>Parallelogram — Rear Mounted</b>	<b>Ripper</b>		<b>Ripper/Scarifier</b>		<b>Ripper</b>		<b>Ripper</b>		<b>Ripper</b>	
<b>Tire Size (std.) Front and Rear</b>	<b>13.00-24</b>		<b>14.00-24***</b>		<b>16.00-24</b>		<b>18.00-25</b>		<b>29.5-29</b>	
Dimensions:										
<b>Scarifier</b>										
Maximum digging depth	—		411 mm	<b>16.2"</b>	—		—		—	
Number of pockets	—		<b>9</b>		—		—		—	
Spacing	—		267 mm	<b>10.5"</b>	—		—		—	
<b>Ripper Shank</b>										
Maximum digging depth	262 mm	<b>10.3"</b>	462 mm	<b>18.2"</b>	401 mm	<b>15.8"</b>	452 mm	<b>17.8"</b>	490 mm	<b>17.3"</b>
Maximum reach at ground line*	1034 mm	<b>3'4.7"</b>	1168 mm	<b>3'10"</b>	1380 mm	<b>4'6.3"</b>	1500 mm	<b>4'11"</b>	1165 mm	<b>3'9.9"</b>
Maximum ground clearance under tip (shank pinned in bottom hole)	652 mm	<b>2'1.6"</b>	521 mm	<b>1'8.5"</b>	663 mm	<b>2'2.1"</b>	673 mm	<b>2'2.5"</b>	739 mm	<b>2'5.1"</b>
Maximum ramp angle, ripper up (shank pinned in bottom hole)	<b>23°</b>		<b>23°</b>		<b>21°</b>		<b>21°</b>		<b>20°</b>	
Shank Section	36 × 76 mm <b>1.4" × 3"</b>		61 × 140 mm <b>2.4" × 5.5"</b>		61 × 140 mm <b>2.4" × 5.5"</b>		76 × 178 mm <b>3" × 7"</b>		78 × 178 mm <b>3" × 7"</b>	
<b>Ripper Beam</b>										
Overall Width	2.30 m	<b>7'7"</b>	2.30 m	<b>7'7"</b>	2.60 m	<b>8'6"</b>	2.98 m	<b>9'9"</b>	3.91 m	<b>12'10"</b>
Height	152 mm	<b>6"</b>	152 mm	<b>6"</b>	165 mm	<b>6.5"</b>	214 mm	<b>8.4"</b>	216 mm	<b>8.5"</b>
Length	182 mm	<b>7.2"</b>	229 mm	<b>9"</b>	211 mm	<b>8.3"</b>	254 mm	<b>10"</b>	254 mm	<b>10"</b>
Number of Pockets	<b>5</b>		<b>5</b>		<b>7</b>		<b>7</b>		<b>7</b>	
Pocket Spacing:										
Inside	533 mm	<b>1'9"</b>	533 mm	<b>1'9"</b>	472 mm	<b>1'7"</b>	500 mm	<b>1'8"</b>	593 mm	<b>1'11.4"</b>
Middle	533 mm	<b>1'9"</b>	533 mm	<b>1'9"</b>	373 mm	<b>15"</b>	445 mm	<b>17.5"</b>	604 mm	<b>1'11.8"</b>
Outside	533 mm	<b>1'9"</b>	533 mm	<b>1'9"</b>	373 mm	<b>15"</b>	445 mm	<b>17.5"</b>	604 mm	<b>1'11.8"</b>
Shank Gauge	2.13 m	<b>7'0"</b>	2.13 m	<b>7'0"</b>	2.44 m	<b>8'0"</b>	—		—	
Installed weights:										
Ripper with standard shank	613 kg	<b>1350 lb</b>	1060.5 kg	<b>2336 lb</b>	1542 kg	<b>3399 lb</b>	2177 kg	<b>4799 lb</b>	2812 kg	<b>6186 lb</b>
Each additional shank	11 kg	<b>24 lb</b>	31 kg	<b>68 lb</b>	31 kg	<b>68 lb</b>	68 kg	<b>150 lb</b>	68 kg	<b>150 lb</b>
Ripper Forces ◀										
Penetration Force ◀	4343 kg	<b>9566 lb</b>	8047 kg**	<b>17,740 lb**</b>	10 676 kg	<b>23,541 lb</b>	10 163 kg	<b>22,410 lb</b>	117 720 N	<b>39,987 lb</b>
Pryout Force	2279 kg	<b>5020 lb</b>	9281 kg	<b>20,460 lb</b>	11 804 kg	<b>26,028 lb</b>	15 323 kg	<b>33,788 lb</b>	263 880 N	<b>59,373 lb</b>

\*Measured from mounting face on frame.

\*\*Applies to 12M and 140M. Penetration force for 160M is 8518 kg (18,780 lb).

\*\*\*12M std. tire is 13.00-24.

NOTE: See Section 1 for Ripper Tips.

◀This value may vary slightly with various vehicle configurations.

**PRODUCTION**

The motor grader is used in a variety of applications in a variety of industries. Therefore, there are many ways to measure its operating capacity, or production. One method expresses a motor grader’s production in relation to the area covered by the moldboard.

**Formula:**

$$A = S \times (L_e - L_o) \times 1000 \times E \text{ (Metric)}$$

$$A = S \times (L_e - L_o) \times 5280 \times E \text{ (English)}$$

- where A: Hourly operating area (m<sup>2</sup>/h or ft<sup>2</sup>/h)  
 S: Operating speed (km/h or mph)  
 L<sub>e</sub>: Effective blade length (m or ft)  
 L<sub>o</sub>: Width of overlap (m or ft)  
 E: Job efficiency

**Operating Speeds:**

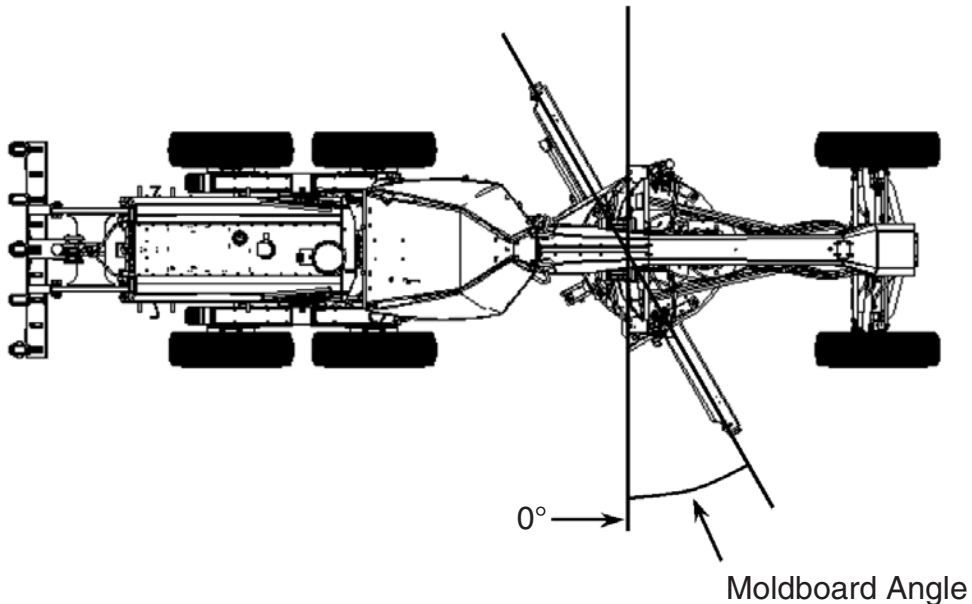
Typical operating speeds by application

Finish Grading:	0-4 km/h	(0-2.5 mph)
Heavy Blading:	0-9 km/h	(0-6 mph)
Ditch Repair:	0-5 km/h	(0-3 mph)
Ripping:	0-5 km/h	(0-3 mph)
Road Maintenance:	5-16 km/h	(3-9.5 mph)
Haul Road Maintenance:	5-16 km/h	(3-9.5 mph)
Snow Plowing:	7-21 km/h	(4-13 mph)
Snow Winging:	15-28 km/h	(9-17 mph)

**Effective Blade Length:**

Since the moldboard is usually angled when moving material, an effective blade length must be computed to account for this angle. This is the actual width of material swept by the moldboard.

**NOTE:** Angles are measured as shown below. The effective length becomes shorter as the angle increases.



Moldboard Length, m (ft)	Effective Length, m (ft) 30 degree blade angle	Effective Length, m (ft) 45 degree blade angle
3.658 (12)	3.17 (10.4)	2.59 (8.5)
3.962 (13)	3.43 (11.3)	2.80 (9.2)
4.267 (14)	3.70 (12.1)	3.02 (9.9)
4.877 (16)	4.22 (13.9)	3.45 (11.3)
7.315 (24)	6.33 (20.8)	5.17 (17.0)

For other blade lengths and carry angles:  
Effective length =  $\text{COS} [\text{Radians (Blade L)}] \times \text{Blade Length}$

### Width of Overlap:

The width of overlap is generally 0.6 m (2.0 ft). This overlap accounts for the need to keep the tires out of the windrow on the return pass.

### Job Efficiency:

Job efficiencies vary based on job conditions, operator skill, etc.

A good estimation for efficiency is approximately 0.70 to 0.85, but actual operating conditions should be used to determine the best value.

### Example problem:

A 140M motor grader with a 3.66 m (12 ft) moldboard is performing road maintenance on a township road. The machine is working at an average speed of 13 km/h (8 mph) with a moldboard carry angle of 30 degrees. What is the motor grader's production based on coverage area?

**Note:** Due to the long passes involved in road maintenance — fewer turnarounds — a higher job efficiency of 0.90 is chosen.

### Solution:

From the table, the effective blade length is 3.17 m (10.4 ft).

#### *Metric*

$$\begin{aligned} \text{Production, A} &= 13 \text{ km/h} \times (3.17 \text{ m} - 0.6 \text{ m}) \times \\ &\quad 1000 \times 0.90 \\ &= \mathbf{30\,069 \text{ m}^2/\text{hr} (3.07 \text{ hectares/hr})} \end{aligned}$$

#### *English*

$$\begin{aligned} \text{Production, A} &= 8 \text{ mph} \times (10.4 \text{ ft} - 2.0 \text{ ft}) \times \\ &\quad 5280 \times 0.90 \\ &= \mathbf{319,334 \text{ ft}^2/\text{hr} (7.33 \text{ acres/hr})} \end{aligned}$$

Figure 1

MOTOR GRADER COMPARISON in HAUL ROAD MAINTENANCE					Worksheet Variables		
	Moderate	Difficult	Moderate	Difficult	Application Variables		
Motor Grader Model	Cat 16M	Cat 16M	Cat 24M	Cat 24M	Pass Overlap Width (m)	Moldboard Angle	Road Width (m)
Haul Road Length Maintained (meters)	1000	1000	1000	1000	2	36	35
Haul Road Width (meters)	35	35	35	35			
Motor Grader Blade Width (meters)	4.9	4.9	7.3	7.3			
Blade Carry Angle	36	36	36	36			
1st Pass Blade Coverage (meters)	3.9	4.0	5.9	5.9			
Remaining Passes Blade Coverage (meters)	1.9	2.0	3.9	3.9			
Grader Passes Required/Road Width	17	17	8	8			
Maintenance Transmission Gear	3	3	3	3			
Maintenance Speed (km/h)	9.0	6.0	10.0	7.0			
<b>Time Analysis:</b>							
Time/Pass (minutes)	6.67	10.00	6.00	8.57			
Maneuver Time/Pass (minutes)	0.50	0.50	0.50	0.50			
Total Time/Pass (minutes)	7.17	10.50	6.50	9.07			
Total Time to Grade Haul Road (hours)	1.91	2.80	0.76	1.06			
Total Time to Grade 1 km (50-min. hour)	2.29	3.36	0.91	1.27			
<b>Road Coverage Requirements</b>							
<b>Coverage Requirement:</b>					<b>Frequency of Maintenance</b>	<b>Percentage</b>	
Total km of Haul Roads	30	30	30	30	Total km of Haul Roads	30	
% Graded One Time Per 14 Shifts (1 week)	10%	10%	10%	10%	Weekly	10%	
% Graded One Time Per 4 Shifts (2 days)	30%	30%	30%	30%	Every other day	30%	
% Graded One Time Per 2 Shifts (1 day)	15%	15%	15%	15%	Daily	15%	
% Graded One Time Per Shift	25%	25%	25%	25%	Once per shift	25%	
% Graded Two Times Per Shift	20%	20%	20%	20%	Twice per shift	20%	
% Graded Three Times Per Shift	0%	0%	0%	0%	Three times per shift	0%	
Total km of Haul Roads/Shift	24.2	24.2	24.2	24.2	Total — must equal 100%	100%	
Working Hours Per Shift	11	11	11	11			
km of Road/Grader/Shift	4.79	3.27	12.08	8.66			
<b>Fleet Requirement:</b>							
“Working” Motor Graders Required/Shift	5.1 to 7.4		2.0 to 2.8				
Motor Grader Mechanical Availability	90%		90%				
Motor Grader Fleet Required (units)	5.6 to 8.2		2.2 to 3.1				

**NOTE:** The above numbers are generated from the formulas and inputs in figure 2. This is the finished spreadsheet’s output when set up according to figure 2.

- Moderate:
- Road Maintenance
  - Pad Cleaning
  - Rock Clearing
  - Shoulder Sweeping

- Difficult:
- Ripping
  - Spreading Dump Material
  - Road Profiling/Reshaping

Figure 2

MOTOR GRADER COMPARISON in HAUL ROAD MAINTENANCE		Worksheet Variables		
	Moderate	Application Variables		
	Cat 16M	Pass Overlap Width (m)	Moldboard Angle	Road Width (m)
Motor Grader Model				
Haul Road Length Maintained (meters)	1000			
Haul Road Width (meters)	= M\$8	2	36	35
Motor Grader Blade Width (meters)	4.88			
Blade Carry Angle	= L\$8			
1st Pass Blade Coverage (meters)	= COS(RADIANS(B10))*B9			
Remaining Passes Blade Coverage (meters)	= B11 - J\$8			
Grader Passes Required/Road Width	= ROUND((B8 - B11)/B12,0)			
Maintenance Transmission Gear	3			
Maintenance Speed (km/h)	9			
<b>Time Analysis:</b>				
Time/Pass (minutes)	= (+ B7/1000)*(60/B15)			
Maneuver Time/Pass (minutes)	0.5			
Total Time/Pass (minutes)	= SUM(B18:B19)			
Total Time to Grade Haul Road (hours)	= B13*B20/60			
Total Time to Grade 1 km (50-min. hour)	= 1000/B7*B22/0.833			
		Road Coverage Requirements		
		Frequency of Maintenance	Percentage	
<b>Coverage Requirement:</b>				
Total km of Haul Roads	= M\$28	Total km of Haul Roads	30	
% Graded One Time Per 14 Shifts (1 week)	= M\$29	Weekly	0.1	
% Graded One Time Per 4 Shifts (2 days)	= M\$30	Every other day	0.3	
% Graded One Time Per 2 Shifts (1 day)	= M\$31	Daily	0.15	
% Graded One Time Per Shift	= M\$32	Once per shift	0.25	
% Graded Two Times Per Shift	= M\$33	Twice per shift	0.2	
% Graded Three Times Per Shift	= M\$34	Three times per shift	0	
Total km of Haul Roads/Shift	= (B28*B29*0.0714) + (B28*B30*0.25) + (B28*B31*0.5) + (B28*B32*1) + (B28*B33*2) + (B28*B34*3)	Total — must equal 100%	= SUM(M29:M34)	
Working Hours Per Shift	11			
km of Road/Grader/Shift	= B37/B24			
<b>Fleet Requirement:</b>				
“Working” Motor Graders Required/Shift	= B35/B38			
Motor Grader Mechanical Availability	0.9			
Motor Grader Fleet Required (units)	= B41/B42			

**NOTE:** The formulas in the “Moderate — Cat 16M” column are the same formulas needed for the “Difficult — Cat 16M,” “Moderate — Cat 24M” and “Difficult — Cat 24M” columns.

Input the data from this spreadsheet exactly how you see it here. This will allow you to generate figure 1. If you have any questions or difficulties please contact the Motor Grader Marketing Group. If you can receive e-mails Motor Grader Marketing will e-mail you the file containing the spreadsheet.

**BLADE PULL**

This specification is also known as drawbar pull. This spec can be calculated as follows:

Variables:

Rear weight of machine =  $Wr$

Tire traction coefficient =  $T$  (Look up the table entitled “Coefficient of Traction Factors”)

$$Wr \times T = \text{Blade Pull}$$

Example problem:

Calculate the blade pull for a 140M Global Version version machine operating in a quarry pit...

*Metric*

$RW = 10\,501\text{ kg}$

$T = 0.65$

$$10\,501 \times 0.65 = 6825.65$$

*English*

$RW = 23,151\text{ lb}$

$T = 0.65$

$$23,151 \times 0.65 = 15,048.15$$

**BLADE DOWN PRESSURE**

This spec can be calculated as follows:

Variables:

Blade to front axle length =  $BA$

Wheel base length =  $WB$

Weight on front wheels =  $FW$

Blade down pressure =  $BD$

$$\frac{WB}{(WB - BA)} \times FW = BD$$

Example problem:

Calculate the blade down pressure for a 140M Global Version version machine...

*Metric*

$BA = 2565\text{ mm}$        $FW = 4223\text{ kg}$

$WB = 6086\text{ mm}$        $BD = ?$

$$\frac{6086}{(6086 - 2565)} \times 4223 = 7299\text{ kg}$$

*English*

$BA = 101\text{ in}$

$FW = 9310\text{ lb}$

$WB = 240\text{ in}$

$BD = ?$

$$\frac{240}{(240 - 101)} \times 9310 = 16,075\text{ lb}$$

This specification is only a minor indicator of a motor grader’s productivity. It alone gives no measure of overall machine productivity. When considering motor grader production you need an optimum balance between the machine’s front and rear weights. If a machine has too much weight on the front axle it might have a high blade down pressure spec, however it will lack the essential rear weight and traction needed to push through the load. Too much weight in the rear and it will not have the necessary weight in the front during heavy cuts to maintain proper steering control.

Cat machines are built with this optimum balance in mind. A Cat motor grader is engineered with the proper weight distribution necessary for maximum productivity.

**Effective Blade Length\***

		Moldboard							
		3.66 m (12')		4.27 m (14')		4.88 m (16')		7.32 m (24')	
Angle°		m	ft	m	ft	m	ft	m	ft
	0°	3.66	12.00	4.27	14.00	4.88	16.00	7.32	24.00
	5°	3.64	11.95	4.25	13.95	4.86	15.94	7.29	23.91
	10°	3.60	11.82	4.20	13.79	4.80	15.76	7.21	23.64
	15°	3.53	11.59	4.12	13.52	4.71	15.45	7.07	23.18
	20°	3.44	11.28	4.01	13.16	4.58	15.04	6.87	22.55
	25°	3.32	10.88	3.87	12.69	4.42	14.50	6.63	21.75
	30°	3.17	10.39	3.69	12.12	4.22	13.86	6.33	20.78
	35°	3.00	9.83	3.50	11.47	4.00	13.11	5.99	19.66
	40°	2.80	9.19	3.27	10.72	3.74	12.26	5.61	18.39
45°	2.59	8.49	3.02	9.90	3.45	11.31	5.17	16.97	

\*Effective blade length is the amount of blade coverage the machine is capable of when the blade is at a given angle.

## EXTREME SLOPE OPERATION

There are two ways of defining slope work. The slope perpendicular to the machines direction of travel is commonly referred to as “Side Sloping.” The slope parallel to the machines direction of travel — the machines ability to travel up or down terrain, is commonly referred to as “Gradeability.”

Side Sloping capability for our M-Series graders is somewhat subjective but general agreement among professional operators is that working on a slope ratio of 2.5:1 (21.8 degrees) is the safe limit ... an experienced operator may be able to operate on a 2:1 (28 degrees) slope. There are many factors, which influence this limit, such as operator experience, machine configuration, tires, soil conditions, but a 2.5:1 is achievable. Further, a 3:1 slope is the approximate maximum side slope a grader can work on in straight frame configuration. The steeper side slopes all require the machine to be articulated to safely negotiate the slope.

Gradeability is approximately 22 degrees. This is established by the graders ability to stop without skidding the tires while moving downhill. The motor grader can, however, *climb* grades steeper than 22 degrees. The traction coefficient is the critical factor in determining whether a grader can safely negotiate the slope. Caterpillar recommends that you never climb a slope steeper than you can safely descend.

Maximum lubrication angle: We have measured the graders on a tilt table and pump cavitation occurs around 45 degrees (100% or 1:1). This is beyond the grade or slope a motor grader can operate on.

When working side hills and slopes, consideration should be given to the following important points.

- **Speed of Travel** — At higher speeds, inertia forces tend to make the grader less stable.
- **Roughness of Terrain or Surface** — Ample allowance should be made where the terrain or surface is uneven.
- **Mounted Equipment** — Mounted attachments such as front plows, snow wings, rippers and other mounted equipment cause the tractor to balance differently.
- **Nature of Surface** — New earthen fills may give way with the weight of the grader. Rocky surfaces may promote side slipping of grader.
- **Wheel Slippage Due to Excessive Loads or Side Draft** — This may cause downhill tire to “dig in,” increasing the angle of grader.
- **Tire Selection and Maintenance** — Consideration should be given to proper tire selection and air pressure. Consult with Caterpillar publication — Motor Grader Tire Selection Guide and Operation and Maintenance manual for more information.
- **Drawbar, Circle and Blade Position** — The position of the blade can affect the stability of the machine.
- **Articulation Angle** — Articulation angle can affect the stability of the machine.
- **Wheel Lean Angle** — Wheel lean angle can affect the stability of the machine.

**NOTE:** Safe operation on steep slopes may require special machine maintenance as well as excellent operator skill and proper equipment setup for the specific application. Consult Operation & Maintenance Manual, Caterpillar publication — Motor Grader Application Guide, and the Grade Comparison Chart in the Tables section of this Performance Handbook, for further operating tips.

<b>Work Tool</b>	<b>120M</b>	<b>12M</b>	<b>140M</b>	<b>160M</b>	<b>14M</b>	<b>16M</b>	<b>24M</b>
Lift Group	x	x	x	x	x	x	—
V-Plow	x	x	x	x	x	x	—
One Way Plow	x	x	x	x	x	x	—
Manual Reversible Plow	x	x	x	x	x	x	—
Hydraulic Reversible Plow	x	x	x	x	x	x	—
Snow Wing	x	x	x	x	x	x	—
Mid Mount Scarifier	x	x	x	x	—	—	—
Front Scarifier	x	x	x	x	—	—	—
Manual Angle Blade	x	x	x	x	x	x	—
Hydraulic Angle Blade	x	x	x	x	x	x	—
Straight Blade	x	x	x	x	x	x	—

This list is not all inclusive.

See Price Lists, Cat Work Tools (CWT) Price List, and your Cat dealer for special attachment needs.

Attachments for Cat motor graders require additional hydraulics.

Most front-mounted attachments require a Quick Attach-Detach Parallel Lift Group.

Contact your Cat dealer for details.