SECOND EDITION

CONSTRUCTION DATABOOK

CONSTRUCTION MATERIALS AND EQUIPMENT

SIDNEY M. LEVY

Construction Databook

About the Author

Sidney M. Levy is an independent construction industry consultant with more than 40 years of experience in the profession. He is the author of numerous books on construction methods and operations, including *Design-Build Project Delivery, Construction Superintendent's Operations Manual,* and *Project Management in Construction* for which he was awarded the British Chartered Institute of Building Silver Medal in the category of Managing Construction.

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Second Edition

New York Chicago San Francisco
Lisbon London Madrid Mexico City
Milan New Delhi San Juan
Seoul Singapore Sydney Toronto

ISBN: 978-0-07-161358-3

MHID: 0-07-161358-7

The material in this eBook also appears in the print version of this title: ISBN: 978-0-07-161357-6, MHID: 0-07-161357-9.

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Introduction

The *Construction DataBook*, *Second Edition*, provides the project manager, construction superintendent, design consultants, facility managers and owners with a one-source guide for the most commonly encountered construction materials and equipment.

Composed of eleven sections ranging, in topics, from excavation and sitework to mechanical and electrical components, the book also includes a handy set of useful tables and formulas. Quick and easy access to informative data on these materials and systems is afforded.

Much of this material has been gleaned from manufacturers and suppliers data but a great deal of these specifications and installation procedures are generic in nature.

The *Construction DataBook, Second Edition* includes several HVAC, plumbing and electrical and alternative energy schematics that explain complex systems in easy-to-understand terms. Installation instructions for subjects as diverse as piles to plastic pipe joining techniques are included in the book. This one-source volume can prove invaluable for office- and field-based design and construction personnel since it contains many of the materials and equipment incorporated in today's building projects.

How many times during project meetings, field visits, or conversations with architects, engineers, general contractors, and subcontractors has it been helpful to have ready access to a concise source of information about product data under discussion? The *Construction DataBook, Second Edition* fulfills that need.

I have selected the construction components, material specifications, and typical installation procedures, that, in my forty years experience in the construction industry appear to be those for which reference material is so often required, and, as usual, required "yesterday."

I hope you find the *Construction DataBook, Second Edition* a worthwhile addition to your construction library.

Sidney M. Levy

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Section

1

Soils, Site Utilities, Sitework Equipment

Contents

1.0.0 Soil Types and Classification

The general classification of soils is divided into the following broad categories:

- Gravel
- Sand
- Silt
- Clay
- Organic

1.0.1 A Glossary to Better Understand Soil Terminology

AASHTO American Association of State Highway and Transportation Officials.

AASHTO T-180 American Association of State Highway and Transportation Officials standard for the modified Proctor test.

AASHTO T-99 American Association of State Highway and Transportation Officials standard for the standard Proctor test.

Aeolian deposits Wind-deposited materials such as sand dunes or other silty-type materials.

Aggregate (coarse or fine) Crushed rock, sand, or gravel that has been graded and may be used as backfill material.

Air gap reading The nuclear density meter test procedure that allows for cancellation of error in reading due to the chemical composition of the soil tested.

Alluvium Material that has been deposited by streams that may no longer exist or that form existing floodplains.

Amplitude The distance an oscillating body moves in one direction from its neutral axis to the outer limit of travel.

Aquifer A geologic formation that provides water in sufficient quantities to create a spring or well.

ASTM American Society for Testing and Materials.

ASTM D 1557 American Society for Testing and Materials standard for the modified Proctor test.

ASTM D 698 American Society for Testing and Materials standard for the standard Proctor test.

Backfill Materials used to refill a cut or other excavation, or the act of such refilling.

Backscatter A method of nuclear density meter soil testing in which the radiation source is placed in contact with the soil surface and density readings are taken from the reflected radiation, the principle being that dense materials absorb more radiation than materials that are not as dense.

Bank A mass of soil that rises above the normal earth level. Generally any soil that is to be dug from its natural position.

Bank-run gravel (run of bank gravel) Gravel as it is excavated from a bank in its natural state.

Bank-yards The measurement of soil or rock taken before digging or disturbing from its original position.

Base The course or layer of materials in a road section on which the actual pavement is placed. This layer may be composed of many different types of materials, ranging from selected soils to crushed stone or gravel.

Base course A layer of material selected to provide a subgrade for some load-bearing structure (such as paving) or to provide some for drainage under a structure above.

Berm An artificial ridge of earth. This term is generally applied to the slide-slopes of a road bed.

Binder A material that passes through a No. 40 U.S. standard sieve that is used to fill voids or hold gravel together.

Borrow pit An excavation from which fill material is taken.

Boulder A rock fragment with a diameter larger than 12 in. (304.8 mm).

Capillary action The cohesive, adhesive, or tensive force that causes water that is contained within soil channels to rise or depress on the normal horizontal plane or level.

Cemented soil Soil in which particles are held together by a chemical agent, such as calcium carbonate.

Centrifugal force The pulling force of an eccentric weight when put in rotary motion that may be changed by varying the rotational speed and/or mass of the eccentric and/or center of gravity (shape) of the eccentric weight.

Clay A cohesive mineral soil consisting of particles less than 0.002 mm in equivalent diameter, a soil textural class, or a fine-grained soil with more than 50 percent passing through a No. 200 sieve that has a high plasticity index in relation to its liquid limit.

Clean Free of foreign material. When used in reference to sand or gravel, it means the lack of a binder.

Cobble A rock fragment, generally oblong or rounded, with an average dimension ranging from 3 in. (75 mm) to 12 in. (305 mm).

Cohesion Shear resistance of soil at zero normal stress; also the quality of some soil particles to attract and stick to like particles; sticking together.

Cohesionless soil A soil that when air-dried in an unconfined space has little cohesion when submerged.

Cohesive material A soil having properties of cohesion.

Cohesive soil A soil that when in an unconfined state has considerable strength when air-dried and submerged.

Compacted yards The cubic measurement of backfill after it has been placed and compacted in fill.

Compaction A process to decrease voids between soil particles when subjected to the forces applied by special equipment.

Compressibility The property of a soil to remain in a compressed state after compaction.

Contact reading A reading by a nuclear density meter when the bottom of the meter is in full contact with the compacted material to be tested.

Core A cylindrical sample of an underground formation, cut and raised by a rotary hollow bit drill.

Crown The center elevation of a road surface used to encourage drainage.

Datum Any level surface used as a plane of reference to measure elevations.

Density The mass of solid particles in a sample of soil or rock.

Double amplitude The distance an oscillating body moves from its neutral axis to the outer limit of its travel in opposite directions.

Dry soil Soil that does not exhibit visible signs of moisture content.

Dynamic linear force The force pounds per inch (lb/in.) seen by the soil as produced by a vibratory roller. Calculated by dividing the centrifugal force by the width of the compacting surface(s).

Eccentric A mass of weight off-balanced to produce centrifugal force (lb) and being part of the exciter unit that produces vibration.

Elasticity Properties that cause soil to rebound after compaction.

Embankment A fill whose top is higher than the adjoining natural compaction.

*End result specification*s Compaction specifications that allow results instead of method specifications to be the determining factor in the selection of equipment.

Exciter The component of a vibratory compactor that creates centrifugal force by means of a power-driven eccentric weight.

Fines The smallest soil particles (less than 0.002 mm) in a graded soil mixture.

Fissured soil Soil material that has a tendency to break along definite planes of fracture with little resistance.

Foot or shoe The bottom part of a vibratory impact rammer contacting the soil.

Frequency The rate at which a vibrating compactor operates, usually expressed in vibrations per minute (VPM).

Glacial till Unstratified glacial materials deposited by the movement of ice and composed of sand, clay, gravel, and boulders in any proportion.

Grade Usually defined as the surface elevation of the ground at points where it meets a structure; also, surface slope.

Grain distribution curve A soil analysis graph showing the percentage of particle size variations by weight.

Granular material A type of soil whose particles are coarser than cohesive material and do not stick to each other.

Granular soil Gravel, sand, or silt with little or no clay content. It has no cohesive strength, cannot be molded when moist, and crumbles easily when dry.

Gravel Round or semiround particles of rock that pass through a 3-in. (76.2-mm) sieve and are retained by a No. 4 U.S. standard sieve [approximately $^1/_4$ in. (6.35 mm)]. It is also defined as an aggregate, consisting of particles that range in size from $^1/_4$ in. (6.35 mm) to 3 in. (76.2 mm).

Gumbo Clays that are distinguished in the plastic state by a soapy or waxy appearance and great toughness.

Hardpan Soil that has become rocklike because of the accumulation of cementing minerals, such as calcium carbonate, in the soil.

Impervious Resistant to movement of water.

In situ The natural, undisturbed soil in place.

Internal friction The soil particle's resistance to movement within the soil mass. For sand, the internal friction is dependent on the gradation, density, and shape of the grain and is relatively independent of the moisture content. For a clay, internal friction varies with the moisture content.

Layered system Two or more distinctly different soil or rock types arranged in layers.

Lift A layer of fill as spread or compacted. A measurement of material depth. The amplitude of a rammer's shoe. The rated effective soil depth a compactor can achieve.

Liquid limit The water content at which the soil changes from a plastic to a liquid state.

Loam A soft, easily worked soil that contains sand, silt, clay, and decayed vegetation.

Loess A uniform aeolian deposit of silty material having an open structure and relatively high cohesion because of the cementation of clay or marl.

Marl Calcareous clay that contains from 35 to 65 percent calcium carbonate.

Muck Mud rich in humus or decayed vegetation.

Mud Generally, any soil containing enough water to make it soft and plastic.

Optimum moisture content Water content at which a soil can be compacted to a maximum-unit dry-unit weight.

Organic clay/soil/silt Clay/soil/silt with high organic content.

Pass A working trip or passage of an excavating, grading, or compaction machine.

Peat A soft, light swamp soil consisting mostly of decayed vegetation.

Perched water table A water table of generally limited area that appears above the normal free-water elevation.

Plasticity A property of soil that allows the soil to be deformed or molded without cracking or causing an appreciable volume change.

Plasticity index The numeric difference between a soil's liquid limit and its plastic limit.

Plastic limit The lowest water content of a soil, at which the soil just begins to crumble when rolled into a cylinder approximately $\frac{1}{8}$ in. (3.17 mm) in diameter.

Proctor modified A moisture–density test of more rigid specifications than the standard Proctor test. The basic difference is use of a heavier weight dropped from a greater distance in laboratory determinations.

Proctor standard A test method developed by R. R. Proctor for determining the density–moisture relationship in soils. It is almost universally used to determine the maximum density of any soil so that specifications may be properly prepared for field construction requirements.

Quicksand Fine sand or silt that is prevented from stabilizing by a continuous upward movement of underground water.

Relative compaction The dry unit of weight of soil compared to the maximum unit weight obtained in a laboratory compaction test and expressed as a ratio.

Silt A soil composed of particles between 0.00024 in. (0.006 mm) and 0.003 in. (0.076 mm) in diameter.

Soil The loose surface material of the earth's crust.

Specific gravity The ratio of weight in air of a given volume of solids at a stated temperature to the weight in air of an equal volume of distilled water at the stated temperature.

Stabilize To make soil firm and prevent it from moving.

Static linear force The force in pounds per inch (lb/in.) seen by the soil as produced by a nonvibratory roller. Calculated by dividing the dead weight of the compactor by the width of the compacting surface(s).

Subbase The layer of selected material placed to furnish strength to the base of a road. In areas where construction goes through marshy, swampy, unstable land, it is often necessary to excavate the natural material in the roadway and replace it with more stable materials. The material used to replace the unstable natural soils is generally called subbase material, and when compacted is known as the subbase.

Subgrade The surface produced grading native earth, or inexpensive materials that serve as a base for a more expensive paving.

VPM Vibrations per minute, derived by the rate of revolutions the exciter makes each minute.

1.1.0 ASTM Unified Soil Classification (USC) System

The American Society for Testing and Materials refers to the Unified Soil Classification system in its ASTM D-2487 specification, the Unified Soil Classification (USC) system.

Unified Soil Classification (USC) System (from ASTM D 2487)				
Major Divisions			**Group Symbol**	**Typical Names**
Coarse-Grained Soils More than 50% retained on the 0.075 mm (No. 200) sieve	**Gravels** 50% or more of coarse fraction retained on the 4.75 mm (No. 4) sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands 50% or more of coarse fraction passes the 4.75 (No. 4) sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils More than 50% passes the 0.075 mm (No. 200) sieve	**Silts and Clays** Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic
Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

1.1.1 ASTM Terminology

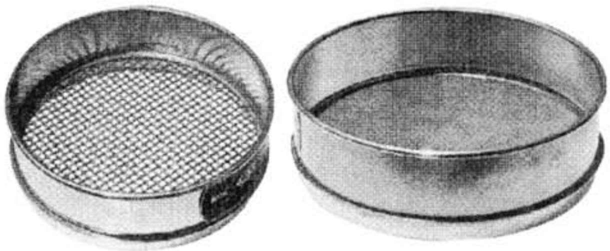
ASTM terminology, as presented in the USC divisions, refers to material retained after passing through a sieve.

The basic reference for the Unified Soil Classification System is ASTM D 2487. Terms include:

Coarse-Grained Soils	More than 50 percent retained on a 0.075 mm (No. 200) sieve.
Fine-Grained Soils	50 percent or more passes a 0.075 mm (No. 200) sieve.
Gravel	Material passing a 75-mm (3-inch) sieve and retained on a 4.75-mm (No. 4) sieve.
Coarse Gravel	Material passing a 75-mm (3-inch) sieve and retained on a 19.0-mm (3/4-inch) sieve.
Fine Gravel	Material passing a 19.0-mm (3/4-inch) sieve and retained on a 4.75-mm (No. 4) sieve.
Sand	Material passing a 4.75-mm sieve (No. 4) and retained on a 0.075-mm (No. 200) sieve.
Coarse Sand	Material passing a 4.75-mm sieve (No. 4) and retained on a 2.00-mm (No. 10) sieve.
Medium Sand	Material passing a 2.00-mm sieve (No. 10) and retained on a 0.475-mm (No. 40) sieve.
Fine Sand	Material passing a 0.475-mm (No. 40) sieve and retained on a 0.075-mm (No. 200) sieve.
Clay	Material passing a 0.075-mm (No. 200) sieve that exhibits plasticity, and strength when dry (PI ^{3} 4).
Silt	Material passing a 0.075-mm (No. 200) sieve that is non-plastic, and has little strength when dry (PI < 4).
Peat	Soil of vegetable matter.

1.1.2 Sieve Size Reference and Sieve Size Chart

Sieve size reference and sieve size chart with both U.S. and metric sieve openings. The terminology is based upon various soils being able to pass through a sieve size containing openings of various sizes.



U.S.A. Sieve Series and Equivalents—A.S.T.M. E-11-87

Sieve Designation		Sieve Opening		Nominal Wire Diameter	
Standard (a)	Alternative	mm	in (approx. equivnts.)	mm	in (approx. equivnts.)
125 mm	5"	125	5.00"	8.00	.3150"
106 mm	4.24"	106	4.24"	6.40	.2520"
100 mm	4"(b)	100	4.00"	6.30	.2480"
90 mm	3.5"	90	3.50"	6.08	.2394"
75 mm	3"	75	3.00"	5.80	.2283"
63 mm	2.5"	63	2.50"	5.50	.2165"
53 mm	2.12"	53	2.12"	5.15	.2028"
50 mm	2"(b)	50	2.00"	5.05	.1988"
45 mm	1.75"	45	1.75"	4.85	.1909"
37.5 mm	1.5"	37.5	1.50"	4.59	.1807"
31.5 mm	1.25"	31.5	1.25"	4.23	.1665"
26.5 mm	1.06"	26.5	1.06"	3.90	.1535"
25.0 mm	1"(b)	25.0	1.00"	3.80	.1496"
22.4 mm	7/8"	22.4	0.875"	3.50	.1378"
19.0 mm	3/4"	19.0	0.750"	3.30	.1299"
16.0 mm	5/8"	16.0	0.625"	3.00	.1181"
13.2 mm	.530"	13.2	0.530"	2.75	.1083"
12.5 mm	1/2"(b)	12.5	0.500"	2.67	.1051"
11.2 mm	7/16"	11.2	0.438"	2.45	.0965"
9.5 mm	3/8"	9.5	0.375"	2.27	.0894"
8.0 mm	5/16"	8.0	0.312"	2.07	.0815"
6.7 mm	.265"	6.7	0.265"	1.87	.0736"
6.3 mm	1/4"(b)	6.3	0.250"	1.82	.0717"
5.6 mm	No. 3-1/2(c)	5.6	0.223"	1.68	.0661"
4.75 mm	No. 4	4.75	0.187"	1.54	.0606"
4.00 mm	No. 5	4.00	0.157"	1.37	.0539"
3.35 mm	No. 6	3.35	0.132"	1.23	.0484"
2.80 mm	No. 7	2.80	0.11"	1.10	.0430"
2.36 mm	No. 8	2.36	0.0937"	1.00	.0394"
2.00 mm	No. 10	2.00	0.0787"	.900	.0345"
1.70 mm	No. 12	1.70	0.0661"	.810	.0319"
1.40 mm	No. 14	1.40	0.0555"	.725	.0285"
1.18 mm	No. 16	1.18	0.0469"	.650	.0256"
1.00 mm	No. 18	1.00	0.0394"	.580	.0228"
850 µm	No. 20	0.850	0.0331"	.510	.0201"
710 µm	No. 25	0.710	0.0278"	.450	.0177"
660 µm	No. 30	0.600	0.0234"	.390	.0154"
500 µm	No. 35	0.500	0.0197"	.340	.0134"
425 µm	No. 40	0.425	0.0165"	.290	.0114"
355 µm	No. 45	0.355	0.0139"	.247	.0097"
300 µm	No. 50	0.300	0.0117"	.215	.0085"
250 µm	No. 60	0.250	0.0098"	.180	.0071"
212 µm	No. 70	0.212	0.0083"	.152	.0060"
180 µm	No. 80	0.180	0.0070"	.131	.0052"
150 µm	No. 100	0.150	0.0059"	.110	.0043"
125 µm	No. 120	0.125	0.0049"	.091	.0036"
106 µm	No. 140	0.106	0.0041"	.076	.0030"
90 µm	No. 170	0.090	0.0035"	.064	.0025"
75 µm	No. 200	0.075	0.0029"	.053	.0021"
63 µm	No. 230	0.063	0.0025"	.044	.0017"
53 µm	No. 270	0.053	0.0021"	.037	.0015"
45 µm	No. 325	0.045	0.0017"	.030	.0012"
38 µm	No. 400	0.038	0.0015"	.025	.0010"
32 µm	No. 450		0.00126"	.0011	
25 µm	No. 500		0.00098"	.001	
20 µm	No. 635		0.00079"	.0008	

(a) These standard designations correspond to the values for test sieve apertures recommended by the International Standards Organization Geneva, Switzerland.
(b) These sieves are not in the fourth root of 2 Series, but they have been included because they are in common usage.
(c) These numbers (3-1/2 to 400) are the approximate number of openings per linear inch but it is preferred that the sieve be identified by the standard designation in millimeters or microns (1000 microns = 1 mm.)

1.1.3 American Association of State Highway and Transportation Officials (AASHTO) Soil Classification System

American Association of State Highway and Transportation Officials (AASHTO) has a somewhat different soil classification system to be used by the states in developing specifications for highway construction purposes.

AASHTO Soil Classification System

The **AASHTO Soil Classification System** was developed by the American Association of State Highway and Transportation Officials, and is used as a guide for the classification of soils and soil-aggregate mixtures for highway construction purposes. The classification system was first developed by in 1929,[1] but has been revised several times since.

AASHTO Soil Classification System (from AASHTO M 145 or ASTM D3282)

General Classification	Granular Materials (35% or less passing the 0.075 mm sieve)							Silt-Clay Materials (>35% passing the 0.075 mm sieve)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis, % passing											
2.00 mm (No. 10)	50 max	...	...	...	...	...	...	...	...	...	...
0.425 (No. 40)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
0.075 (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid Limit	...		...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min[1]
Usual types of significant constituent materials	stone fragments, gravel and sand		fine sand	silty or clayey gravel and sand				silty soils		clayey soils	
General rating as a subgrade	excellent to good							fair to poor			

Note (1): Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

From Wikipedia, the free encyclopedia.

[1] Hogentogler, C.A., Terzaghe, K. (May 1929). " Interrelationship of load, road and subgrade", *Public Roads*; pp. 37–64.

1.1.4 Properties of Soils, U.S. Department of Agriculture (USDA)

Properties of soils modified by the U.S. Department of Agriculture (USDA) to reflect soil groups that range from excellent to unsatisfactory based upon drainage, frost heave susceptibility, and potential volume changes.

Soil Group	Unified Soil Classification Symbol	Soil Description	Drainage Characteristics[1]	Frost Heave Susceptibility[2]	Volume Change Potential Expansion[3]
Group I *Excellent*	GW	Well-graded gravel, gravel-sand mixtures, little or no fines	Good	Low (F1)	Low
	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines	Good	Low (F1) to Medium (F2)	Low
	SW	Well-graded sands, gravely sands, little or no fines	Good	Medium (F2)	Low
	SP	Poorly graded sands, gravely sands, little or no fines	Good	Medium (F2)	Low
	GM	Silty gravels, gravel-sand-clay mixtures	Medium	Low (F1) to High (F3)	Low
	SM	Silty sand, sand-silt mixtures	Medium	Mekium (F2) to High (F3)	Low
Group II *Fair to Good*	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	High (F3)	Low
	SC	Clayey sand, sand-clay mixtures	Medium	High (F3)	Low
	ML	Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity	Medium	Very High (F4)	Low
	CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	Medium	High (F3) to Very High (F4)	Medium
Group III *Poor*	CH	Inorganic clays of high plasticity, fat clays	Poor	High (F3)	High to Very High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils	Poor	Very High (F4)	High
Group IV *Unsatisfactory*	OL	Organic silts and organic silty clays of low plasticity	Poor	High (F3)	Medium
	OH	Organic sands of medium to high plasticity, organic silts	Unsatisfactory	High (F3)	High
	PT	Peat and other high organic soils	Unsatisfactory	High (F3)	High

Source: Table modified from the U.S. Department of Agriculture (www.usda.gov).

1 Percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 to 4 inches per hour, and poor drainage is less than 2 inches per hour.

2 After Coduto, D.P.(2001). *Foundation Design.* Prentice-Hall. F1 indicates soils that are least susceptible to frost heave, and F4 indicates soils that are most susceptible to frost heave.

3 For expansive soils, contact a geotechnical engineer for verification of design assumptions. Dangerous expansion might occur if soils classified as having medium to very high potential expansion types are dry but then are subjected to future wetting.

1.1.5 USDA and *FEMA Coastal Construction Manual* Bearing Capacity Data

USDA and *FEMA Coastal Construction Manual* data include bearing capacity data, shear strength and angle of internal friction data, and grading of various types of soils as excellent, fair to good, or poor.

Table 7 Engineering Properties of Soils

Soil Group	Unified Soil Classification Symbol	Bearing Capacity (psf)	Undrained Shear Strength[1] (psf)	Angle of Internal Friction (degrees)
Group I *Excellent*	GW	2,700-3,000	NA	38-46
	GP	2,700-3,000	NA	38-46
	SW	800-1,200 (loose)	NA	30-46 (loose to dense)
	SP	800-1,200 (loose)	NA	30-36 (loose to dense)
	GM	2,700-3,000	NA	38-46
	SM	1,600-3,500 (firm)	NA	28-40 (firm)
Group II *Fair to Good*	GC	2,700-3,000	NA	38-46
	SC	1,600-3,500 (firm)	NA	30-34 (dense)
	ML	2,000	NA	30-34 (dense)
	CL	600-1,200 (soft) — 3,000-4,500 (stiff)	0-250 (soft) — 1,000-1,200 (stiff)	NA
Group III *Poor*	CH	600-1,200 (soft) — 3,000-4,500 (stiff)	250-500 (soft) — 2,000-4,000 (stiff)	NA
	MH	2,000	1,600	NA

Source: Table modified from the U.S. Department of Agriculture (www.usda.gov), *FEMA Coastal Construction Manual* (www.fema.gov), and Bardet, J. (1997). *Experimental Soil Mechanics*. Prentice-Hall.

[1] The undrained shear strength is also commonly referred to as cohesion in saturated clays.

psf = pounds per square foot NA = not applicable

1.1.6 Typical Soil Bearing Capacity Categories

Typical soil bearing capacities can be roughly categorized as follows:

- Crystalline bedrock — 12,000 pounds per square foot
- Sedimentary rock — 6,000 pounds per square foot
- Sandy gravel or gravel — 5,000 pounds per square foot
- Sand, silty sand, clayey sand, silty gravel — 3,000 pounds per square foot
- Clay, sandy clay, silty clay — 2,000 pounds per square foot

Source: Table 401.4.1, *CABO-1 & 2 Family Houses Code*, 1995.

1.2.0 Soil Test Boring Report

The geotechnical report assembled by an owner when a new construction project is anticipated will include test borings to acquaint bidding contractors with the general nature of the site's subsurface conditions.

LOG OF BORING No. B-1

CLIENT:	**DATE:** 6-22-99	#02995604	**RIG:** CME 75
SITE:	**PROJECT:**		

GRAPHIC LOG	DESCRIPTION	DEPTH ft.	USCS SYMBOL	NUMBER	TYPE	RECOVERY in.	SPT – N BLOWS/ft	WATER CONTENT %	DRY UNIT WT. pcf	UNCONFINED STRENGTH q_u psf	ATTERBERG LIMITS LL, PL, PI
	6" GRAVEL LEAN CLAY, silty trace organics, gray brown, trace dark brown and red brown, medium (Possible Fill)				PA						
			CL	1	SS	14	7	34.1		2000*	45,21,34
	LEAN CLAY, calcareous, trace sand and limestone gravel dark brown, brown, very stiff (Possible Fill)	5			HS						
		10	CL	2	SS	6	5	18.6		7000*	45,23,22
					HS						
	LEAN CLAY, trace silt, gray brown, trace dark gray, red brown and dark brown, stiff to very stiff	15	CL	3	SS	24	9	24.1		5500*	
					HS						
		20	CL	4	SS	24	10	22.3		3500*	44,20,24
					HS						
	LEAN CLAY, silty, gray brown, trace dark brown, stiff to very stiff	25	CL	5	SS	24	5	27.6		2500*	
					HS						
		30	CL	6	SS	24	19	26.5		5000*	42,18,24
					HS						
	Trace limonites at 34.0' LEAN TO FAT CLAY, gray brown, trace dark brown, very stiff	35	CL-CH	7	SS	24	14	23.5		5000*	
					HS						

1.2.1 Stratum Description Column in Boring Log

A stratum description column is included in the boring log and makes reference to soils description in more general terms, such as topsoil, gravel, and dense or medium sand. This log and report is often accompanied by the civil engineer's soils classification terminology that mostly parallels that of the USC and includes a component gradation designation and a fines fraction chart.

1.2.1.1 Fines Fraction, Plasticity

Fines fraction, plasticity, component gradation terms, and density/consistency tables accompany the civil engineer's soils report. The smallest thread diameter rolled portion of the table refers to the smallest diameter the soil sample can be rolled into by hand.

COMPONENT GRADATION TERMS

MATERIAL	FRACTION	SIEVE SIZE
GRAVEL	COARSE	3/4" TO 3"
	FINE	NO. 4 TO 3/4"
SAND	COARSE	N0. 10 TO NO. 4
	MEDIUM	NO. 40 TO NO. 10
	FINE	NO. 200 TO NO. 40
FINES		PASSING NO. 200

FINES FRACTION

PLASTICITY	PI	NAME	SMALLEST THREAD DIA ROLLED
NON-PLASTIC	0	SILT	NONE
SLIGHT	1-5	Clayey SILT	1/4"
LOW	5-10	SILT & CLAY	1/8"
MEDIUM	10-20	CLAY & SILT	1/16"
HIGH	20-40	Silty CLAY	1/32"
VERY HIGH	>40	CLAY	1/64"

1.2.1.2 Bedrock Weathering Classifications

BEDROCK WEATHERING CLASSIFICATION

GRADE	SYMBOL	DIAGNOSTIC FEATURES
Fresh	F	No visible signs of decomposition or discoloration. Rings under hammer impact.
Slightly Weathered	WS	Slight discoloration inwards from open fractures, otherwise similar to F.
Moderately Weathered	WM	Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock but cores cannot be broken by hand or scraped by knife. Texture preserved.
Highly Weathered	WH	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.
Completely Weathered	WC	Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
Residual Soil	RS	Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

1.2.1.3 Mechanical Properties of Rock

TABLE 1. MECHANICAL PROPERTIES OF VARIOUS ROCKS

Rock	Young's Modulus at Zero Load (10^5 kg/cm^2)	Bulk Density (g/cm^3)	Porosity (percent)	Compressive Strength (kg/cm^2)	Tensile Strength (kg/cm^2)
Granite	2 - 6	2.6-2.7	0.5-1.5	1,000-2,500	70-250
Microgranite	3 - 8				
Syenite	6 - 8				
Diorite	7-10			1,800-3,000	150-300
Dolerite	8-11	3.0-3.05	0.1-0.5	2,000-3,500	150-350
Gabbro	7-11	3.0-3.1	0.1-0.2	1,000-3,000	150-300
Basalt	6-10	2.8-2.9	0.1-1.0	1,500-3,000	100-300
Sandstone	0.5-8	2.0-2.6	5 - 25	200-1,700	40-250
Shale	1-3.5	2.0-2.4	10 - 30	100-1,000	20-100
Mudstone	2 - 5				
Limestone	1 - 8	2.2-2.6	5 - 20	300-3,500	50-250
Dolomite	4-8.4	2.5-2.6	1 - 5	800-2,500	150-250
Coal	1 - 2			50-500	20-50
Quartzite		2.65	0.1-0.5	1,500-3,000	100-300
Gneiss		2.9-3.0	0.5-1.5	500-2,000	50-200
Marble		2.6-2.7	0.5-2	1,000-2,500	70-200
Slate		2.6-2.7	0.1-0.5	1,000-2,000	70-200

Note:
1. For the igneous rocks listed above Poisson's ratio is approximately 0.25.
2. For a certain rock type, the strength normally increases with increase in density and increase in Young's modulus. (After Farmer, 1968)
3. Taken from *"Foundation Engineering Handbook"* by Winterkorn and Fong, Van Nostrand Reinhold, pg. 72.

By permission: Atlas Systems, Inc., Independence, Missouri.

1.3.0 Soil Compaction Methods

Soil compaction is simply the method by which the density of soil can be increased by mechanical or often natural ways. Ponding of water on shallow layers of soil can cause soil consolidation, as can placing an overburden on soils that were previously excavated and placed in an area where compacted soil is required. Both of these methods are time-consuming and not very practical on the typical fast-moving construction project.

Compacting soils accomplishes a number of things:

- It provides structural integrity to the soil, thereby increasing its load-bearing capacity.
- It prevents later settlement of nonstructural soils.
- It reduces water seepage and the resultant heave and contraction.

Soils can be compacted by various types of mechanical action:

- Vibration. A downward force is created by rotating a concentric weight or piston attached to a roller.
- Static. Weight is merely applied by the force of a heavy piece of equipment rolling back and forth across the area to be compacted.
- Impact. This is a repeated ramming action.

1.3.1 Soil Compaction Equipment

Compaction machines produce two types of forces: *frequency* and *amplitude*. Frequency is the speed at which an eccentric shaft within the compaction machine rotates and is expressed as vibrations per minute (VPM). Amplitude is the maximum movement of the vibrating body from one axis to another. A machine with double amplitude exhibits that movement in both directions from its axis.

1.3.1.1 Flat Plate Compactor

1.3.1.2 Rammer-Type Compactor

1.3.1.3 Walk-behind Trench Compactor

1.3.1.4 Riding Tandem Drum Compactor

1.3.2 Importance of Depth of Soil Layer to Be Compacted

Civil engineers are quick to point out that areas to be backfilled must be compacted in 6-in. layers. By understanding the way in which compaction equipment works, it is rather easy to see why this 6-in. rule is important.

As the compaction machine rides over the soil to be compacted, the impact travels to the hard surface below the newly placed layer and then returns upward. This action places all the soil particles in action, and compaction commences. With a short distance to travel, say 6 in., the impact down and back is quicker, and therefore proper compaction occurs more quickly. The thicker the uncompacted soil layer, the longer it will take to compact.

Overcompaction can also occur if the compaction equipment is operated over the area for too long a period. This will produce cracks and fissures in compacted soil, resulting in reduced overall density.

1.3.3 Quick Reference of Compaction Equipment Applications for Various Types of Soils

For granular soils compaction by vibration is the most effective. Vibration decreases friction between soil particles, thereby allowing them to eliminate all air voids and rearrange themselves into a very tightly compacted configuration. This vibratory effect penetrates deep in the soil so that slightly thicker layers can be compacted, requiring fewer passes. In smaller areas vibratory plate compactors are used; in large areas, vibratory rollers provide better production.

The smaller the soil particle, the higher the natural resonant frequencies must be; the larger the particle, the lower the required frequency. A lightweight vibratory late compactor with a high frequency of 6250 vibrations per minute and a low amplitude is the best equipment for finer and medium sands.

For cohesive soils, impact equipment is preferable. The impact force creates a shearing effect on the soil that binds the flat, pancake-shaped soil particles together and in the process squeezes out air pockets. A high ramming speed of 500 to 700 impacts per minute also creates a vibratory effect that works well with granular as well as cohesive soils. A vibratory trench roller with sheep's foot-like cleats also performs well on cohesive soils because it creates the shearing action necessary for proper compaction.

Summation

- Granular soils—vibratory plate or smooth drum vibratory roller.
- Cohesive soils—rammer or vibratory trench roller.
- Mixed soils—use any rammer or trench roller.

1.3.4 Pea Gravel Compaction

Some contractors are of the opinion that pea gravel does not require compaction, but that concept is incorrect. Because the surface of pea gravel is irregular and not nearly round, as it appears to the eye, it too should be compacted so that each particle settles and essentially compacts.

1.3.5 Compaction Methods

There are several methods by which the compaction of soil can be determined.

1.3.6.0 Hand Test

Squeezing a soil sample in one's hand is one easy, quick way to get an unscientific but pretty good idea whether the soil's moisture content and composition will be readily compactable. When squeezed in the hand, the soil sample that is moldable and breaks into a few small pieces probably will compact properly. If the soil sample is powdery and falls apart easily in the hand, it is an indication that moisture will be required to gain acceptable compaction. And if the sample has too much moisture content, it will stick to one's palm and fingers and retain its shape when dropped.

1.3.6.1 Standard Proctor Test, ASTM D 698

The more definitive and scientific approach to ensuring the proper compaction of soils is the Proctor test, which determines the maximum achievable density of the soil sample by driving out the moisture and then weighing the sample.

Objective — To determine the optimum moisture content and dry density of a compacted soil sample.

Procedure

1. Obtain 2500 g of oven dry (air dry will work, but not as well) soil passed through the #4 sieve.

2. Weigh 1 "bread pan" moisture content container and record the weight on the data sheet.

3. Weigh a 4 inch diameter compaction mold. (V = 1/30 of a cubic foot)

4. Add enough water to your sample to obtain a 14% moisture content (remember water content is Ww/Ws). If using air dry soil, remember to consider the moisture content of air dry soil and only add enough water to get to 14% moisture. If your air dry soil already has 4% moisture, you need to take that into account.

5. Compact the soil into the mold in **three layers** using a **5.5** pound hammer and 25 blows per layer. Make sure that on the last layer, your compacted sample is just above (1/4" or so) the top of the mold so it can be trimmed and weighed.

6. Weigh the mold and the sample (in pounds) and record on your data sheet.

7. Take a representative sample of the soil (about half of it evenly distributed from the entire sample) and place in a "bread pan" moisture content container. Weigh the sample, record the data, and place in the oven. Work quickly because water is being lost as time progresses.

8. Repeat steps 1 through 7 twice, increasing the moisture content to 18% for the 2nd point and then 22% for the third point.

9. Obtain all weights the following day and plot moisture content vs. dry unit weight to scale on graph paper and indicate optimum moisture and maximum dry unit weight.

1.3.6.3 Modified Proctor Test, ASTM D 1557

Basically this is the same as the standard Proctor test except a 10-lb (4.5-kg) hammer is dropped 18 in. (45.7 cm) on five layers of soil.

Objective — To determine the optimum moisture content and dry density of a compacted soil sample.

Procedure (The same as the Standard except you use a 10 lb hammer, 18" drop, 5 layers)

1. Obtain 2500 g of oven dry (air dry will work, but not as well) soil passed through the #4 sieve.

2. Weigh 3 "bread pan" moisture content containers individually and record weights on the data sheet in your manual.

3. Weigh a 4 inch diameter compaction mold. (V = 1/30 of a cubic foot)

4. Add enough water to your sample to obtain a 12% moisture content (300 g of water).

5. Compact the soil into the mold in **FIVE** layers using a **10 pound hammer** and 25 blows per layer. Make sure that on the last layer, your compacted sample is just above (1/4" or so) the top of the mold so it can be trimmed and weighed.

6. Weigh the mold and the sample (in pounds) and record on your data sheet.

7. Take a representative sample of the soil (about half of it evenly distributed from the entire sample) and place in a "bread pan" moisture content container. Weigh the sample, record the data, and place in the oven. Work quickly because water is being lost as time progresses.

8. Repeat steps 1 through 7 twice, increasing the moisture content to 15% for the 2nd point and then 18% for the third point.

9. Obtain all weights the following day and plot moisture content vs. dry unit weight to scale on graph paper and indicate optimum moisture and maximum dry unit weight.

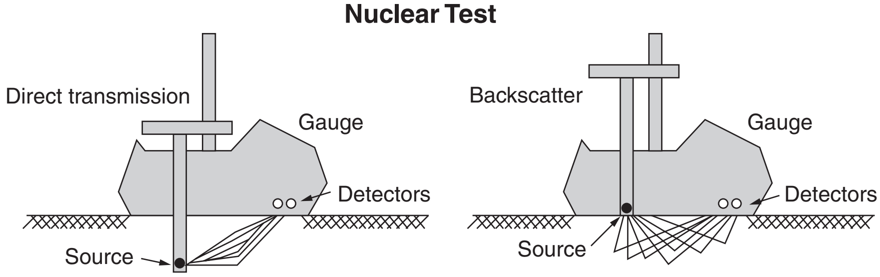
1.3.6.3 Nuclear Density Test, ASTM D 2292-91

This method of testing uses a radioactive isotope, cesium 137, in a probe driven into the soil. The isotope gives off gamma rays which radiate back to the detectors located in the bottom of the device. Since dense soil absorbs more radiation than loosely packed soil, the readings provide the soil density. There are two basic types of probes: in one, a radioactive source is mounted near the tip of the probe, and in the other, the probe is inserted into a preformed hole.

1.3.6.4 Diagram of a Nuclear Density Testing Device

Nuclear Density (ASTM D 2292-91)
Nuclear density meters are a quick and fairly accurate way of determining density and moisture content. The meter uses a radioactive isotope source (cesium 137) at the soil surface (backscatter) or from a probe placed into the soil (direct transmission). The isotope source gives off photons (usually gamma rays) which radiate back to the matter's detectors on the bottom of the unit. Dense soil absorbs more radiation than loose soil and the readings reflect overall density. Water content (ASTM D 3017) can also be read, all within a few minutes. A relative Proctor density with the compaction results from the test.

Nuclear Test

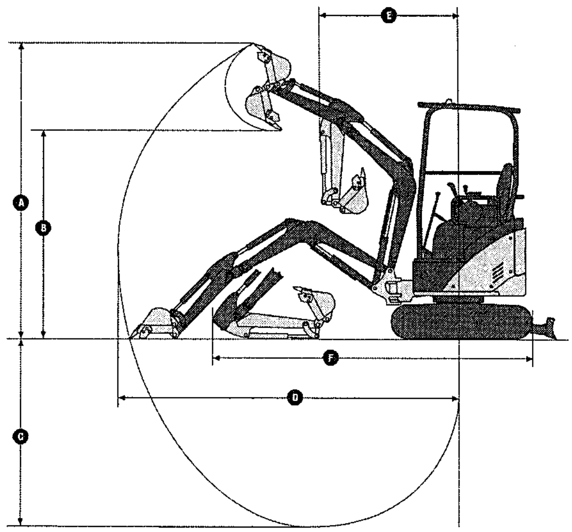


1.4.0 Excavation Equipment—Excavators

From mini-excavators to large tracked giants, there are several manufacturers producing equipment to suit every need. Moline, Illinois-based John Deere presents such a complete line; a portion of each type is illustrated here.

1.4.1 Mini-excavators

John Deere model 17D.



Operating Weights

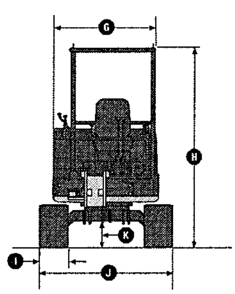
	3 ft. 1 in. (0.93 m) Standard Arm and Standard Counterweight	3 ft. 8 in. (1.13 m) Long Arm and Extra Counterweight
With Full Fuel Tank and 175-lb. (79 kg) Operator		
With Rubber Track	4,173 lb. (1893 kg)	4,364 lb. (1979 kg)
With Steel Track	4,319 lb. (1959 kg)	4,508 lb. (2045 kg)

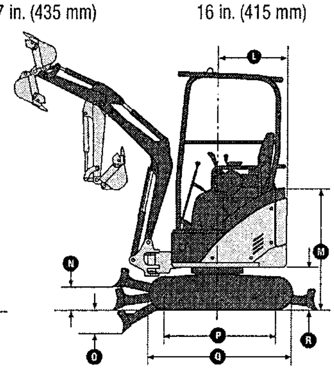
Operating Dimensions

	3 ft. 1 in. (0.93 m) Standard Arm and Standard Counterweight	3 ft. 8 in. (1.13 m) Long Arm and Extra Counterweight
A Maximum Digging Height	11 ft. 8 in. (3.56 m)	12 ft. (3.66 m)
B Maximum Dumping Height	8 ft. 4 in. (2.53 m)	8 ft. 8 in. (2.63 m)
C Maximum Digging Depth	7 ft. 1 in. (2.17 m)	7 ft. 9 in. (2.37 m)
D Maximum Digging Reach	12 ft. 10 in. (3.90 m)	13 ft. 5 in. (4.08 m)
E Minimum Front Swing Radius	5 ft. 1 in. (1.54 m)	5 ft. 4 in. (1.63 m)
F Transport Length	11 ft. 9 in. (3.59 m)	11 ft. 11 in. (3.64 m)
Bucket Breakout Force	3,597 lb. (16.0 kN)	3,597 lb. (16.0 kN)
Arm Breakout Force	2,316 lb. (10.3 kN)	2,046 lb. (9.1 kN)

Machine Dimensions

	3 ft. 1 in. (0.93 m) Standard Arm, Standard Counterweight, and Rubber Track	3 ft. 8 in. (1.13 m) Long Arm, Extra Counterweight, and Rubber Track	3 ft. 1 in. (0.93 m) Standard Arm, Standard Counterweight, and Steel Track	3 ft. 8 in. (1.13 m) Long Arm, Extra Counterweight, and Steel Track
Blade Width				
Minimum	3 ft. 3 in. (0.98 m)			
Maximum	4 ft. 2 in. (1.28 m)			
Blade Height	10.2 in. (260 mm)			
G Upperstructure Width	3 ft. 3 in. (0.98 m)	3 ft. 3 in. (0.98 m)	3 ft. 3 in. (0.98 m)	3 ft. 3 in. (0.98 m)
H Overall Height to Roof	7 ft. 10 in. (2.40 m)	7 ft. 10 in. (2.40 m)	7 ft. 10 in. (2.40 m)	7 ft. 10 in. (2.40 m)
I Track Width	9 in. (230 mm)	9 in. (230 mm)	9 in. (230 mm)	9 in. (230 mm)
J Undercarriage Width				
Minimum	3 ft. 2 in. (0.97 m)	3 ft. 2 in. (0.97 m)	3 ft. 2 in. (0.97 m)	3 ft. 2 in. (0.97 m)
Maximum	4 ft. 2 in. (1.28 m)	4 ft. 2 in. (1.28 m)	4 ft. 2 in. (1.28 m)	4 ft. 2 in. (1.28 m)
K Ground Clearance	6.5 in. (165 mm)	6.5 in. (165 mm)	5.7 in. (145 mm)	5.7 in. (145 mm)
L Tail Swing Radius	27 in. (675 mm)	30 in. (755 mm)	27 in. (675 mm)	30 in. (755 mm)
M Engine Cover Height	4 ft. (1.23 m)	4 ft. (1.23 m)	4 ft. (1.23 m)	4 ft. (1.23 m)
N Maximum Blade Lift Above Ground	11.2 in. (285 mm)	11.2 in. (285 mm)	11.2 in. (285 mm)	11.2 in. (285 mm)
O Maximum Blade Drop Below Ground	9.4 in. (240 mm)	9.4 in. (240 mm)	9.4 in. (240 mm)	9.4 in. (240 mm)
P Sprocket Center To Idler Center	4 ft. (1.21 m)	4 ft. (1.21 m)	3 ft. 11 in. (1.20 m)	3 ft. 11 in. (1.20 m)
Q Track Length	5 ft. 2 in. (1.57 m)	5 ft. 2 in. (1.57 m)	5 ft. 1 in. (1.55 m)	5 ft. 1 in. (1.55 m)
R Counterweight Clearance	17 in. (435 mm)	17 in. (435 mm)	16 in. (415 mm)	16 in. (415 mm)





Lift Capacities

	3 ft. 1 in. (0.93 m) Standard Arm, Standard Counterweight, and Rubber Track	3 ft. 8 in. (1.13 m) Long Arm, Extra Counterweight, and Rubber Track	3 ft. 1 in. (0.93 m) Standard Arm, Standard Counterweight, and Steel Track	3 ft. 8 in. (1.13 m) Long Arm, Extra Counterweight, and Steel Track
Over Front, Blade Down (limited by hydraulics)	979 lb. (444 kg)	963 lb. (437 kg)	979 lb. (444 kg)	963 lb. (437 kg)
Over Side	500 lb. (227 kg)	559 lb. (254 kg)	524 lb. (238 kg)	583 lb. (264 kg)

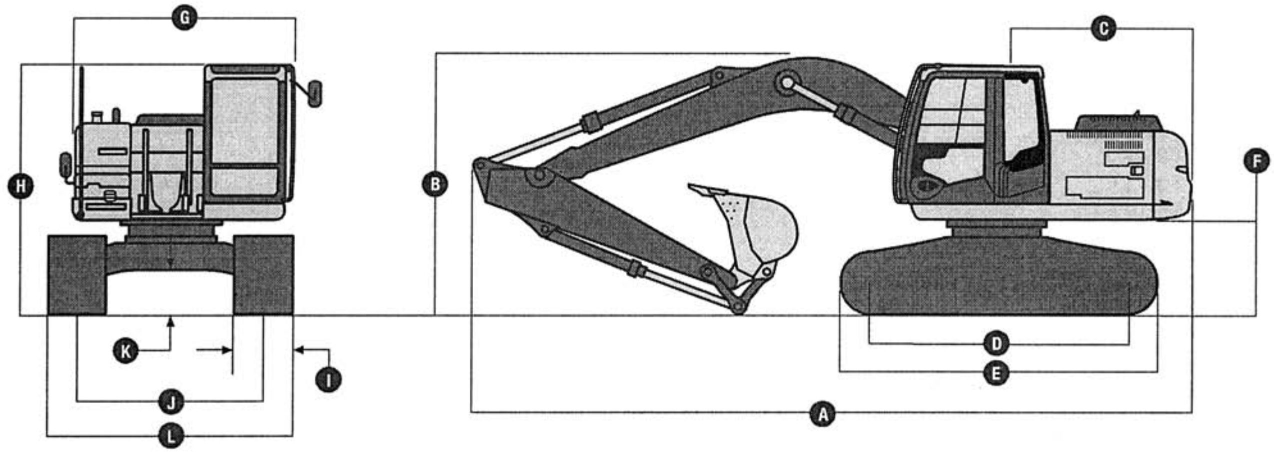
By permission, Deere & Company, Moline, Illinois.

1.4.2 Midsized Track Excavator

John Deere model 160D.

Machine Dimensions

		Arm Length 8 ft. 6 in. (2.60 m)	*Arm Length 10 ft. 2 in. (3.01 m)*
A	Overall Length	28 ft. 1 in. (8.55 m)	28 ft. 2 in. (8.58 m)
B	Overall Height	9 ft. 5 in. (2.87 m)	10 ft. 2 in. (3.11 m)
C	Rear-End Length/Swing Radius	8 ft. 2 in. (2.49 m)	
D	Distance Between Idler/Sprocket Centerline	10 ft. 2 in. (3.10 m)	
E	Undercarriage Length	12 ft. 10 in. (3.92 m)	
F	Counterweight Clearance	3 ft. 3 in. (1001 mm)	
G	Upperstructure Width	8 ft. 2 in. (2.48 m)	
H	Cab Height	9 ft. 8 in. (2.95 m)	
I	Track Width with Triple Semi-Grouser Shoes	24 in. (600 mm) / 28 in. (700 mm)	
J	Gauge Width	6 ft. 6 in. (1.99 m)	
K	Ground Clearance	19 in. (470 mm)	
L	Overall Width with Triple Semi-Grouser Shoes		
	24 in. (600 mm)	8 ft. 6 in. (2.60 m)	
	28 in. (700 mm)	8 ft. 10 in. (2.70 m)	



Lift Charts

Boldface italic type indicates hydraulic-limited capacities; lightface type indicates stability-limited capacities, in lb. (kg). Ratings are at bucket lift hook, using standard counterweight, situated on firm, level, uniform supporting surface. Figures do not exceed 87 percent of hydraulic capacity or 75 percent of weight needed to tip machine.

Load Point	5 ft. (1.52 m)		10 ft. (3.05 m)		15 ft. (4.57 m)		20 ft. (6.10 m)		25 ft. (7.62 m)	
Height	Over Front	Over Side	Over Front	Over Side	Over Front	Over Side	Over Front	Over Side	Over Front	Over Side
With 8-ft. 6-in. (2.60 m) arm, 0.78-cu.-yd. (0.60 m³) bucket, and 24-in. (600 mm) triple semi-grouser shoes										
20 ft. (6.10 m)							***5,470 (2481)***	***5,470 (2481)***		
15 ft. (4.57 m)							***6,568 (2979)***	6,411 (2908)		
10 ft. (3.05 m)					***9,265 (4203)***	***9,265 (4203)***	***7,684 (3485)***	6,107 (2770)	***5,803 (2632)***	4,073 (1847)
5 ft. (1.52 m)					***12,523 (5680)***	8,920 (4046)	***9,160 (4155)***	5,733 (2600)	6,443 (2922)	3,922 (1779)
Ground Line					14,137 (6412)	8,388 (3805)	8,959 (4064)	5,438 (2467)	6,300 (2858)	3,789 (1719)
–5 ft. (–1.52 m)			***13,758 (6241)***	***13,758 (6241)***	13,949 (6327)	8,226 (3731)	8,810 (3996)	5,302 (2405)		
–10 ft. (–3.05 m)	***18,000 (8165)***	***18,000 (8165)***	***16,758 (7601)***	16,167 (7333)	14,052 (6374)	8,315 (3772)	8,875 (4026)	5,361 (2432)		
–15 ft. (–4.57 m)			***15,450 (7008)***	***15,450 (7008)***	***10,825 (4910)***	8,315 (3772)				
With 8-ft. 6-in. (2.60 m) arm, 0.78-cu.-yd. (0.60 m³) bucket, and 28-in. (700 mm) triple semi-grouser shoes										
20 ft. (6.10 m)							***5,470 (2481)***	***5,470 (2481)***		
15 ft. (4.57 m)							***6,568 (2979)***	6,507 (2952)		
10 ft. (3.05 m)					***9,265 (4203)***	***9,265 (4203)***	***7,684 (3485)***	6,202 (2813)	***5,803 (2632)***	4,146 (1881)
5 ft. (1.52 m)					***12,523 (5680)***	9,057 (4108)	***9,160 (4155)***	5,829 (2644)	6,552 (2972)	3,995 (1812)
Ground Line					14,356 (6512)	8,525 (3867)	9,105 (4130)	5,534 (2510)	6,410 (2908)	3,862 (1752)
–5 ft. (–1.52 m)			***13,758 (6241)***	***13,758 (6241)***	14,169 (6427)	8,363 (3793)	8,956 (4062)	5,398 (2448)		
–10 ft. (–3.05 m)	***18,000 (8165)***	***18,000 (8165)***	***16,798 (7619)***	16,411 (7444)	***14,174 (6429)***	8,452 (3834)	9,021 (4092)	5,457 (2475)		
–15 ft. (–4.57 m)			***15,450 (7008)***	***15,450 (7008)***	***10,825 (4910)***	8,832 (4006)				

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1.4.2 Midsized Track Excavator (Continued)

Ground Pressure

Triple Semi-Grouser Shoes	
24 in. (600 mm)	6.16 psi (42.5 kPa)
28 in. (700 mm)	5.40 psi (37.2 kPa)

Serviceability

Refill Capacities

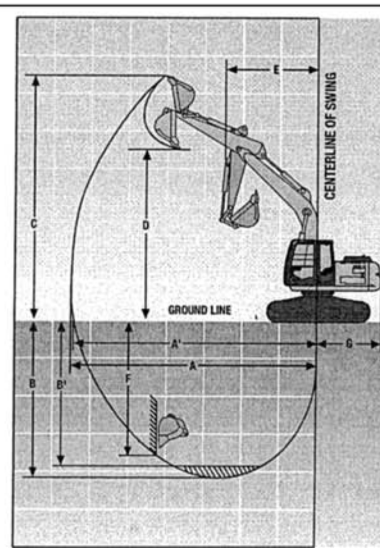
Fuel Tank	85 gal. (320.0 L)
Cooling System	23 qt. (22.0 L)
Engine Oil with Filter	16 qt. (15.0 L)
Hydraulic Tank	33 gal. (125.0 L)
Hydraulic System	52.0 gal. (196.8 L)
Gearbox	
Propel (each)	5.0 qt. (4.7 L)
Swing	6.0 qt. (5.7 L)

Operating Weights

With Full Fuel Tank; 175-lb. (79 kg) Operator; 36-in. (914 mm), 0.81-cu.-yd. (0.62 m³), 1,373-lb. (623 kg) Heavy-Duty Bucket; 10-ft. 2-in. (3.10 m) Arm; 7,275-lb. (3300 kg) Counterweight; 12-ft. 10-in. (3.92 m) Undercarriage Length; and Triple Semi-Grouser Shoes	
24 in. (600 mm)	39,508 lb. (17 937 kg)
28 in. (700 mm)	39,980 lb. (18 151 kg)
Optional Components	
Undercarriage with Triple Semi-Grouser Shoes	
24 in. (600 mm)	13,911 lb. (6316 kg)
28 in. (700 mm)	14,383 lb. (6530 kg)
Upperstructure with Full Fuel Tank (less front attachments and 7,275-lb. [3300 kg] counterweight)	7,917 lb. (3594 kg)
One-Piece Boom (with arm cylinder)	2,864 lb. (1300 kg)
Arm with Bucket Cylinder and Linkage	
8 ft. 6 in. (2.60 m)	1,735 lb. (788 kg)
10 ft. 2 in. (3.10 m)	1,925 lb. (874 kg)
Boom Lift Cylinders (2) Total Weight	675 lb. (306 kg)
36-in. (914 mm), 0.81-cu.-yd. (0.62 m³) Heavy-Duty Bucket	1,373 lb. (623 kg)
Counterweight (standard)	7,275 lb. (3300 kg)

Operating Dimensions

	Arm Length 8 ft. 6 in. (2.60 m)	*Arm Length 10 ft. 2 in. (3.10 m)*
Arm Force with 36-in. (914 mm), 0.81-cu.-yd. (0.62 m³) Heavy-Duty Bucket	19,352 lb. (86.1 kN)	17,243 lb. (76.7 kN)
Bucket Digging Force with 36-in. (914 mm), 0.81-cu.-yd. (0.62 m³) Heavy-Duty Bucket	22,697 lb. (101.0 kN)	22,697 lb. (101.0 kN)
Lifting Capacity Over Front at Ground Level 20-ft. (6.1 m) Reach	9,105 lb. (4134 kg)	9,094 lb. (4129 kg)
A Maximum Reach	29 ft. 1 in. (8.87 m)	30 ft. 7 in. (9.33 m)
A' Maximum Reach at Ground Level	28 ft. 7 in. (8.70 m)	30 ft. 1 in. (9.16 m)
B Maximum Digging Depth	19 ft. 7 in. (5.98 m)	21 ft. 4 in. (6.49 m)
B' Maximum Digging Depth at 8-ft. (2.44 m) Flat Bottom	18 ft. 10 in. (5.74 m)	20 ft. 7 in. (6.27 m)
C Maximum Cutting Height	29 ft. 2 in. (8.88 m)	29 ft. 11 in. (9.13 m)
D Maximum Dumping Height	20 ft. 3 in. (6.17 m)	21 ft. 0 in. (6.40 m)
E Minimum Swing Radius	9 ft. 7 in. (2.91 m)	9 ft. 7 in. (2.92 m)
F Maximum Vertical Wall	16 ft. 11 in. (5.16 m)	18 ft. 8 in. (5.69 m)
G Tail Swing Radius	8 ft. 2 in. (2.49 m)	8 ft. 2 in. (2.49 m)



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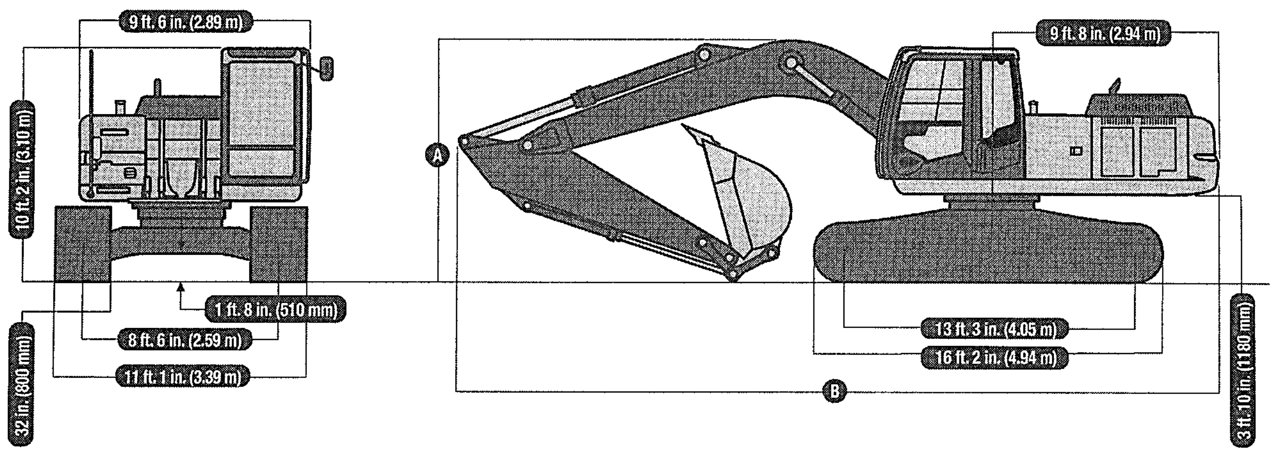
1.4.3 Large Track Excavator

John Deere model 270D.

Dimensions

A 10-ft. 2-in. (3.11 m) arm . . . . 10 ft. 5 in. (3.17 m)
12-ft. 4-in. (3.75 m) arm . . . . 11 ft. 0 in. (3.35 m)

B 10-ft. 2-in. (3.11 m) arm . . . . 33 ft. 11 in. (10.34 m)
12-ft. 4-in. (3.75 m) arm . . . . 35 ft. 3 in. (10.74 m)



Lift Capacities

Boldface italic type indicates hydraulic-limited capacities; lightface type indicates stability-limited capacities, in lb. (kg). Ratings at bucket lift hook; machine equipped with 1.75-cu.-yd. (1.34 m^3), 42-in. (1065 mm), 2,279-lb. (1034 kg) bucket; 13,447-lb. (6100 kg) counterweight; standard gauge; and situated on firm, uniform supporting surface. Total load includes weight of cables, hook, etc. Figures do not exceed 87 percent of hydraulic capacities or 75 percent of weight needed to tip machine. All lift capacities are based on SAE J1097.

Load Point	10 ft. (3.05 m)		15 ft. (4.57 m)		20 ft. (6.10 m)		25 ft. (7.62 m)		30 ft. (9.15 m)	
Height	Over Front	Over Side	Over Front	Over Side	Over Front	Over Side	Over Front	Over Side	Over Front	Over Side
With 12-ft. 4-in. (3.75 m) arm and 32-in. (800 mm) triple semi-grouser shoes										
25 ft. (7.62 m)							***8,490 (3851)***	***8,490 (3851)***		
20 ft. (6.10 m)							***8,629 (3914)***	***8,629 (3914)***	***5,984 (2714)***	***5,984 (2714)***
15 ft. (4.57 m)							***9,676 (4389)***	***9,676 (4389)***	***9,609 (4359)***	7,937 (3600)
10 ft. (3.05 m)			***17,039 (7729)***	***17,039 (7729)***	***13,189 (5982)***	***13,189 (5982)***	***11,405 (5173)***	10,668 (4839)	***10,524 (4774)***	7,680 (3484)
5 ft. (1.52 m)			***24,377 (11 057)***	22,290 (10 111)	***16,795 (7618)***	14,398 (6531)	***13,401 (6079)***	10,091 (4577)	***11,626 (5274)***	7,371 (3343)
Ground Line			***28,866 (13 094)***	20,936 (9497)	***19,727 (8948)***	13,562 (6152)	***15,195 (6892)***	9,601 (4355)	12,245 (5554)	7,096 (3219)
–5 ft. (–1.52 m)	***15,885 (7205)***	***15,885 (7205)***	***30,355 (13 769)***	20,481 (9290)	***21,412 (9712)***	13,102 (5943)	16,083 (7295)	9,284 (4211)	12,055 (5468)	6,922 (3140)
–10 ft. (–3.05 m)	***22,504 (10 208)***	***22,504 (10 208)***	***29,877 (13 552)***	20,489 (9294)	***21,738 (9860)***	12,972 (5884)	15,965 (7242)	9,178 (4163)	***10,392 (4714)***	6,920 (3139)
–15 ft. (–4.57 m)	***30,876 (14 005)***	***30,876 (14 005)***	***27,577 (12 509)***	20,821 (9444)	***20,489 (9294)***	13,131 (5956)	***15,518 (7039)***	9,328 (4231)		
–20 ft. (–6.10 m)	***30,941 (14 035)***	***30,941 (14 035)***	***22,517 (10 214)***	21,537 (9769)	***16,452 (7463)***	13,673 (6202)				
With 10-ft. 2-in. (3.11 m) arm and 32-in. (800 mm) triple semi-grouser shoes										
20 ft. (6.10 m)							***10,107 (4585)***	***10,107 (4585)***		
15 ft. (4.57 m)					***11,760 (5334)***	***11,760 (5334)***	***10,993 (4986)***	10,981 (4981)	***8,349 (3787)***	7,778 (3528)
10 ft. (3.05 m)			***20,484 (9291)***	***20,484 (9291)***	***14,959 (6785)***	***14,959 (6785)***	***12,603 (5717)***	10,494 (4760)	***11,531 (5230)***	7,587 (3441)
5 ft. (1.52 m)			***27,306 (12 386)***	21,575 (9786)	***18,319 (8309)***	14,121 (6405)	***14,426 (6544)***	9,976 (4525)	***12,445 (5645)***	7,332 (3326)
Ground Line			***28,596 (12 971)***	20,733 (9404)	***20,773 (9423)***	13,441 (6097)	***15,959 (7239)***	9,564 (4338)	12,256 (5559)	7,117 (3228)
–5 ft. (–1.52 m)	***14,458 (6558)***	***14,458 (6558)***	***30,272 (13 731)***	20,588 (9339)	***21,875 (9922)***	13,133 (5957)	16,127 (7315)	9,337 (4235)	12,156 (5514)	7,026 (3187)
–10 ft. (–3.05 m)	***23,292 (10 565)***	***23,292 (10 565)***	***29,066 (13 184)***	20,762 (9418)	***21,566 (9782)***	13,130 (5956)	16,121 (7312)	9,332 (4233)		
–15 ft. (–4.57 m)	***29,503 (13 382)***	***29,503 (13 382)***	***25,803 (11 704)***	21,225 (9628)	***19,419 (8808)***	13,422 (6088)				

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1.4.3 Large Track Excavator (Continued)

Ground Pressure Data

Average Ground Pressure
32-in. (800 mm) Triple Semi-Grouser Shoes
(recommended for general/soft terrain) . . . 5.84 psi (40.3 kPa)

Capacities (U.S.)

Fuel Tank	132 gal. (500 L)
Cooling System	31.6 qt. (29.9 L)
Engine Lubrication, Including Filter	26 qt. (24.6 L)
Hydraulic Tank	39 gal. (148 L)
Hydraulic System	63.4 gal. (240 L)
Propel Gearbox (each)	9 qt. (8.5 L)
Swing Drive	8 qt. (7.6 L)

SAE Operating Weights

With Full Fuel Tank; 175-lb. (79 kg) Operator; 1.75-cu.-yd. (1.34 m³), 42-in. (1065 mm), 2,279-lb. (1034 kg) Bucket; 12-ft. 4-in. (3.75 m) Arm; 13,447-lb. (6100 kg) Counterweight; and 32-in. (800 mm) Triple Semi-Grouser Shoes . . . 63,425 lb. (28 770 kg)

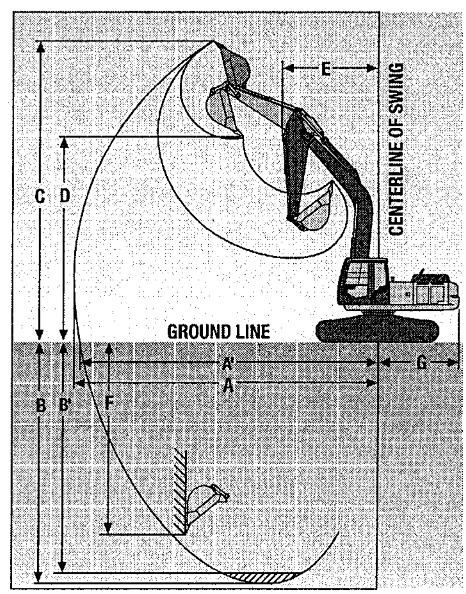
Component Weights

Undercarriage	
32-in. (800 mm) Triple Semi-Grouser Shoes	25,937 lb. (11 765 kg)
One-Piece Boom (with arm cylinder)	5,086 lb. (2307 kg)
Arm with Bucket Cylinder and Linkage	
10 ft. 2 in. (3.11 m)	3,102 lb. (1407 kg)
12 ft. 4 in. (3.75 m)	3,298 lb. (1496 kg)
Boom Lift Cylinders (2) Total Weight	1,098 lb. (494 kg)
1.75-cu.-yd. (1.34 m³), 42-in. (1065 mm) Heavy-Duty High-Capacity Bucket	2,279 lb. (1034 kg)
Counterweight	13,447 lb. (6100 kg)

Operating Information

	Arm Length 10 ft. 2 in. (3.11 m)	*Arm Length 12 ft. 4 in. (3.75 m)*
Arm Force with 32-in. (800 mm) Triple Semi-Grouser Shoes*	29,518 lb. (131.3 kN)	25,979 lb. (115.55 kN)
Bucket Digging Force with 32-in. (800 mm) Triple Semi-Grouser Shoes*	37,480 lb. (166.7 kN)	37,480 lb. (166.7 kN)
Lifting Capacity Over Front @ Ground Level 20-ft. (6.1 m) Reach*	20,773 lb. (9423 kg)	19,727 lb. (8948 kg)
A Maximum Reach	35 ft. 3 in. (10.74 m)	37 ft. 1 in. (11.30 m)
A' Maximum Reach @ Ground Level	34 ft.7 in. (10.55 m)	36 ft. 6 in. (11.12 m)
B Maximum Digging Depth	23 ft. 10 in. (7.26 m)	25 ft. 11 in. (7.91 m)
B' Maximum Digging Depth @ 8-ft. (2.44 m) Flat Bottom	23 ft. 2 in. (7.05 m)	25 ft. 8 in. (7.72 m)
C Maximum Cutting Height	32 ft. 10 in. (10.01 m)	34 ft. 4 in. (10.46 m)
D Maximum Dumping Height	23 ft. 2 in. (7.07 m)	24 ft. 7 in. (7.49 m)
E Minimum Swing Radius	13 ft. 7 in. (4.41 m)	12 ft. 9 in. (3.89 m)
F Maximum Vertical Wall	20 ft. 1 in. (6.11 m)	23 ft. 1 in. (7.03 m)
G Tail Swing Radius	9 ft. 8 in. (2.94 m)	9 ft. 8 in. (2.94 m)

*Digging forces and lift capacities with power boost.



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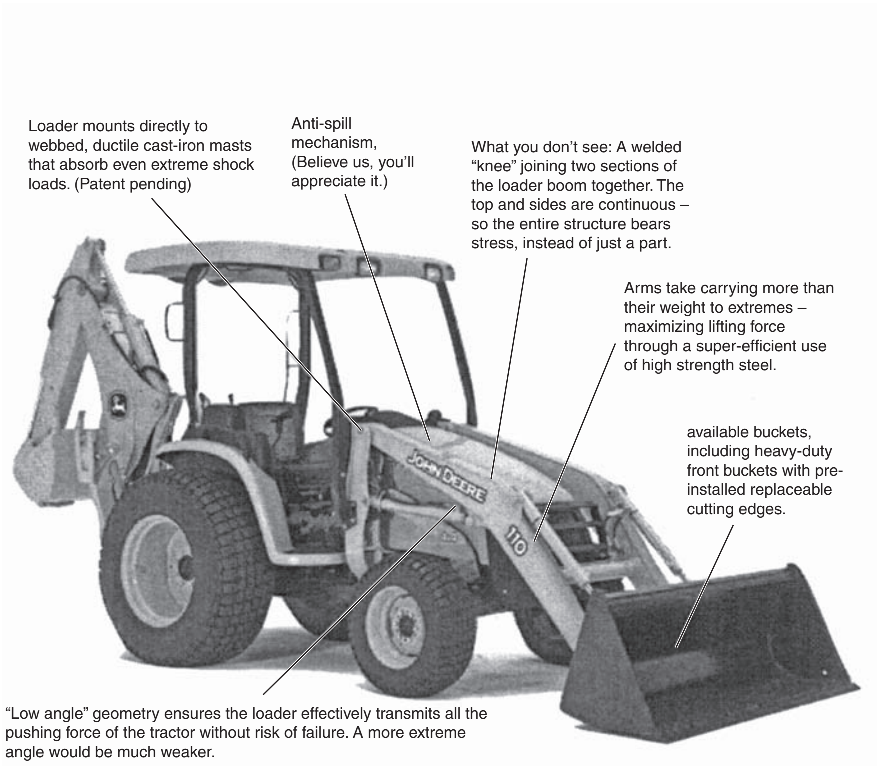
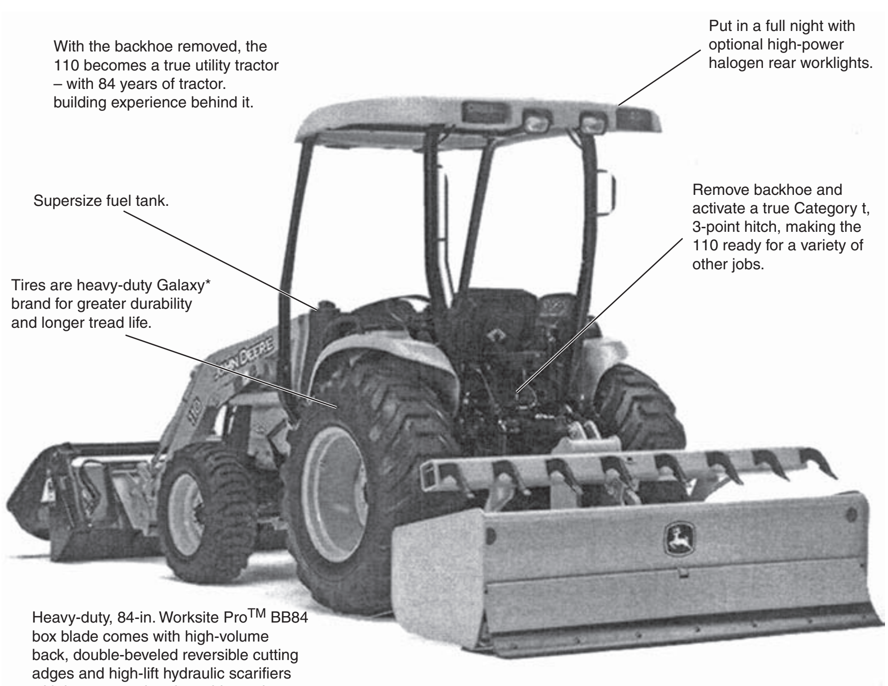
1.5.0 Small Rubber Tire Backhoe

Small rubber tire backhoes, 100 Series. A 43-hp, small backhoe with a maximum depth reach of 10 ft (3.05 m) and a lift height reach of 9.67 ft (2.94 m). Miscellaneous attachments are available for general grading, auguring, and grading.





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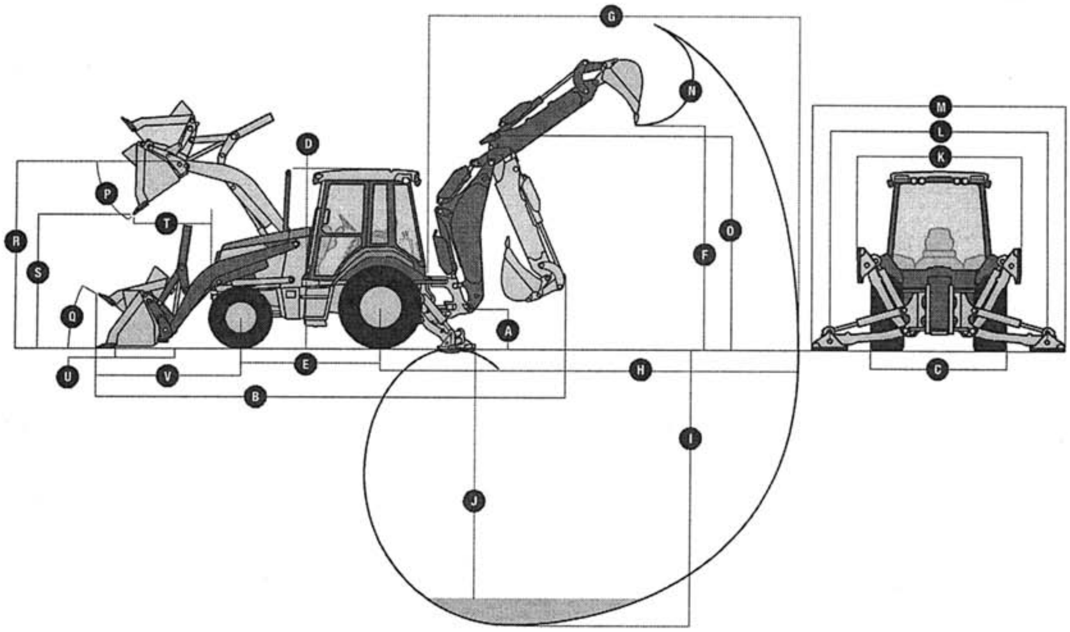
1.5.1 Midsize Rubber Tire Backhoe

Model 310. A 92-hp midsize machine pictured with optional forklift attachment.

Overall Dimensions

A	Ground Clearance (minimum)	13 in. (330 mm)
B	Overall Length (transport)	23 ft. 6 in. (7.16 m)
C	Width over Tires	7 ft. 2 in. (2.18 m)
D	Height to Top of ROPS/Cab	9 ft. 2 in. (2.79 m)
E	Length from Axle to Axle	
	Non-Powered Front Axle	6 ft. 11 in. (2.11 m)
	Mechanical-Front-Wheel-Drive Axle	7 ft. 0 in. (2.14 m)



Backhoe Dimensions / Performance

Backhoe specifications are with 24-in. x 7.5-cu.-ft. (610 mm x 0.21 m³) bucket

	Bucket Range	12–30 in. (305–762 mm)	
	Digging Force		
	Bucket Cylinder	15,236 lb. (67.8 kN)	
	Crowd Cylinder	8,090 lb. (36.0 kN)	
	Swing Arc	180 deg.	
	Operator Control	two joysticks	
		With Extendable Dipperstick	
		Retracted	*Extended*
F	Loading Height (truck loading position)	11 ft. 3 in. (3.43 m)	14 ft. 1 in. (4.29 m)
G	Reach from Center of Swing Pivot	18 ft. 7 in. (5.66 m)	21 ft. 11 in. (6.68 m)
H	Reach from Center of Rear Axle	22 ft. 1 in. (6.73 m)	25 ft. 4 in. (7.72 m)
I	Digging Depth (SAE maximum)	14 ft. 11 in. (4.55 m)	18 ft. 5 in. (5.61 m)
J	Digging Depth (SAE)		
	2-ft. (610 mm) Flat Bottom	14 ft. 9 in. (4.50 m)	18 ft. 3 in. (5.56 m)
	8-ft. (2440 mm) Flat Bottom	13 ft. 9 in. (4.19 m)	17 ft. 6 in. (5.33 m)
K	Stabilizer Width (transport with ROPS)	7 ft. 2 in. (2.18 m)	7 ft. 2 in. (2.18 m)
L	Stabilizer Spread (operating)		
	Standard Stabilizers	10 ft. 2 in. (3.10 m)	10 ft. 2 in. (3.10 m)
	Long Stabilizers	11 ft. 4 in. (3.45 m)	11 ft. 4 in. (3.45 m)
M	Stabilizer Overall Width (operating)		
	Standard Stabilizers	11 ft. 7 in. (3.53 m)	11 ft. 7 in. (3.53 m)
	Long Stabilizers	13 ft. 3 in. (4.03 m)	13 ft. 3 in. (4.03 m)
N	Bucket Rotation	190 deg.	190 deg.
O	Transport Height	11 ft. 5 in. (3.48 m)	11 ft. 5 in. (3.48 m)

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1.5.1 Midsize Rubber Tire Backhoe (Continued)

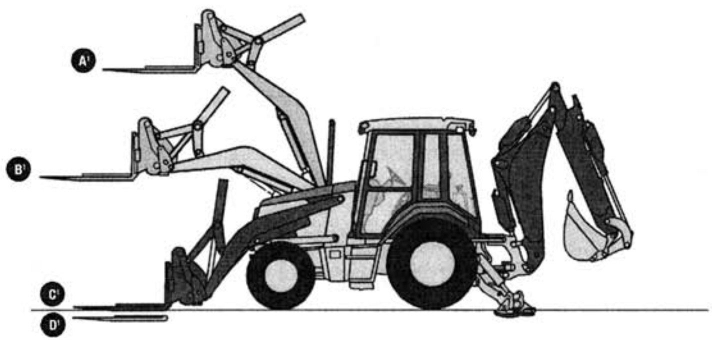
Loader Dimensions / Performance

(see page 4 for line art)

P Bucket Dump Angle (maximum)	45 deg.					
Q Rollback Angle at Ground Level	40 deg.					
	Heavy-duty	*Heavy-duty*	*Heavy-duty long lip*	*Heavy-duty*	*Multipurpose*	*Multipurpose*
Bucket Capacity	1.00 cu. yd. (0.77 m^3)	1.12 cu. yd. (0.86 m^3)	1.25 cu. yd. (0.96 m^3)	1.31 cu. yd. (1.00 m^3)	1.25 cu. yd. (0.96 m^3)	1.31 cu. yd. (1.00 m^3)
Width	86 in. (2184 mm)	86 in. (2184 mm)	86 in. (2184 mm)	92 in. (2337 mm)	86 in. (2184 mm)	92 in. (2337 mm)
R Height to Bucket Hinge Pin (maximum)	11 ft. 2 in. (3.40 m)	11 ft. 2 in. (3.40 m)	11 ft. 2 in. (3.40 m)	11 ft. 2 in. (3.40 m)	11 ft. 2 in. (3.40 m)	11 ft. 2 in. (3.40 m)
Standard Loader Option						
Weight	800 lb. (363 kg)	860 lb. (390 kg)	892 lb. (405 kg)	1,148 lb. (521 kg)	1,750 lb. (795 kg)	1,800 lb. (817 kg)
Breakout Force	11,160 lb. (49.6 kN)	11,051 lb. (49.2 kN)	10,210 lb. (45.4 kN)	10,300 lb. (45.8 kN)	9,700 lb. (43.1 kN)	9,650 lb. (42.9 kN)
Lift Capacity (full height)	7,419 lb. (3368 kg)	7,353 lb. (3338 kg)	7,340 lb. (3332 kg)	7,200 lb. (3269 kg)	6,700 lb. (3042 kg)	6,600 lb. (2996 kg)
S Dump Clearance (bucket at 45 deg.)	8 ft. 10 in. (2.69 m)	8 ft. 10 in. (2.69 m)	8 ft. 2 in. (2.48 m)	8 ft. 8 in. (2.64 m)	8 ft. 7 in. (2.62 m)	8 ft. 7 in. (2.62 m)
T Reach at Full Height (bucket at 45 deg.)	30.9 in. (785 mm)	30.2 in. (767 mm)	35.9 in. (911 mm)	30.1 in. (765 mm)	32.2 in. (818 mm)	32.2 in. (818 mm)
U Digging Depth Below Ground (bucket level)	6.3 in. (160 mm)	6.9 in. (175 mm)	5.8 in. (147 mm)	8.1 in. (206 mm)	7.3 in. (185 mm)	7.3 in. (185 mm)
V Length From Front Axle Centerline to Bucket Cutting Edge	6 ft. 8 in. (2.03 m)	6 ft. 8 in. (2.03 m)	7 ft. 2 in. (2.18 m)	6 ft. 8 in. (2.03 m)	7 ft. 3 in. (2.20 m)	7 ft. 1 in. (2.15 m)
Tool-Carrier Loader Option						
Weight	835 lb. (379 kg)	873 lb. (396 kg)	860 lb. (390 kg)	1,085 lb. (493 kg)	1,687 lb. (766 kg)	1,737 lb. (789 kg)
Breakout Force	11,287 lb. (50.2 kN)	11,900 lb. (52.9 kN)	10,300 lb. (45.8 kN)	11,450 lb. (50.9 kN)	9,740 lb. (43.3 kN)	9,680 lb. (43.1 kN)
Lift Capacity (full height)	7,026 lb. (3190 kg)	7,200 lb. (3269 kg)	6,625 lb. (3008 kg)	7,215 lb. (3276 kg)	5,950 lb. (2701 kg)	5,850 lb. (2656 kg)
S Dump Clearance (bucket at 45 deg.)	8 ft. 6 in. (2.58 m)	8 ft. 7 in. (2.61 m)	8 ft. 3 in. (2.51 m)	8 ft. 6 in. (2.59 m)	8 ft. 2 in. (2.50 m)	8 ft. 2 in. (2.50 m)
T Reach at Full Height (bucket at 45 deg.)	30.6 in. (777 mm)	29.3 in. (744 mm)	34.2 in. (868 mm)	30.0 in. (762 mm)	32.9 in. (836 mm)	32.9 in. (836 mm)
U Digging Depth Below Ground (bucket level)	5.5 in. (140 mm)	5.5 in. (140 mm)	4.8 in. (122 mm)	5.5 in. (140 mm)	6.0 in. (152 mm)	6.0 in. (152 mm)
V Length From Front Axle Centerline to Bucket Cutting Edge	7 ft. 1 in. (2.15 m)	7 ft. 1 in. (2.15 m)	7 ft. 7 in. (2.30 m)	7 ft. 1 in. (2.15 m)	7 ft. 7 in. (2.32 m)	7 ft. 5 in. (2.27 m)

Lift Capacity with Quick-Coupler / Forks

A' Maximum Height	4,875 lb. (2211 kg)
B' Maximum Reach	7,580 lb. (3438 kg)
C' At Ground Line	9,700 lb. (4400 kg)
D' Below Ground Line	8.3 in. (211 mm)



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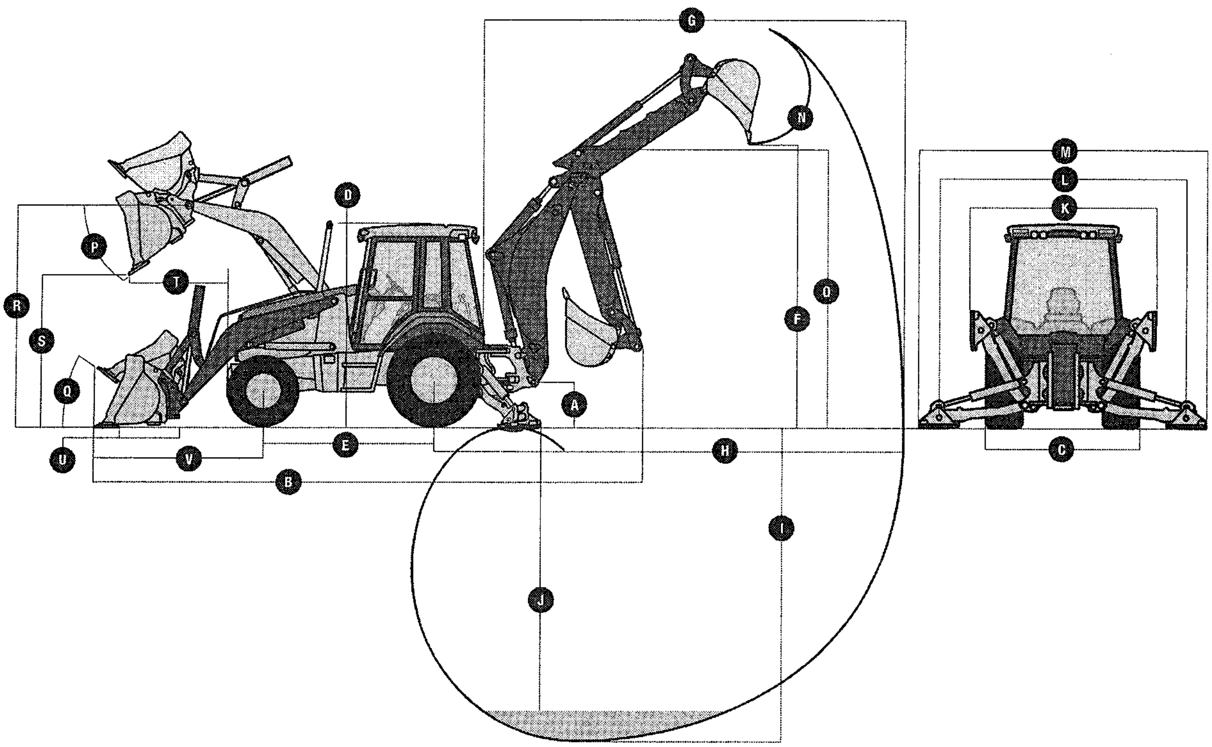
1.5.2 Large-Capacity Backhoe

Deere's large-capacity backhoe, model 710J, with 123-hp turbocharged engine.

Overall Dimensions

A	Ground Clearance (minimum)	14 in. (356 mm)
B	Overall Length (transport)	26 ft. 9 in. (8.15 m)
C	Width over Tires	7 ft. 6 in. (2.29 m)
D	Height to Top of ROPS/Cab	9 ft. 9 in. (2.97 m)
E	Length from Axle to Axle	
	Non-Powered Front Axle	8 ft. 3 in. (2.52 m)
	Mechanical-Front-Wheel-Drive Axle	8 ft. 2 in. (2.49 m)



Backhoe Dimensions / Performance

Backhoe specifications are with 24-in. x 11.1-cu.-ft. (610 mm x 0.31 m³) bucket

Bucket Range	24–36 in. (610–914 mm)
Digging Force	
Bucket Cylinder	17,000 lb. (75.6 kN)
Crowd Cylinder	11,750 lb. (52.3 kN)
Swing Arc	180 deg.
Operator Control	pilot control

		With Standard Backhoe	*With Optional Extendable Dipperstick Retracted*	*Extended*
F	Loading Height (truck loading position)	14 ft. 3 in. (4.34 m)	14 ft. 3 in. (4.34 m)	17 ft. 0 in. (5.18 m)
G	Reach from Center of Swing Pivot	22 ft. 6 in. (6.86 m)	22 ft. 6 in. (6.86 m)	26 ft. 10 in. (8.19 m)
H	Reach from Center of Rear Axle	26 ft. 8 in. (8.13 m)	26 ft. 8 in. (8.13 m)	31 ft. 0 in. (9.46 m)
I	Digging Depth (SAE maximum)	17 ft. 10 in. (5.44 m)	17 ft. 10 in. (5.44 m)	22 ft. 4 in. (6.81 m)
J	Digging Depth (SAE)			
	2-ft. (610 mm) Flat Bottom	17 ft. 9 in. (5.41 m)	17 ft. 9 in. (5.41 m)	22 ft. 5 in. (6.83 m)
	8-ft. (2440 mm) Flat Bottom	17 ft. 0 in. (5.18 m)	17 ft. 0 in. (5.18 m)	21 ft. 7 in. (6.58 m)
K	Stabilizer Width (transport with ROPS)	7 ft. 11 in. (2.41 m)	7 ft. 11 in. (2.41 m)	7 ft. 11 in. (2.41 m)
L	Stabilizer Spread (operating)	13 ft. 1 in. (3.99 m)	13 ft. 1 in. (3.99 m)	13 ft. 1 in. (3.99 m)
M	Stabilizer Overall Width (operating)	15 ft. 3 in. (4.65 m)	15 ft. 3 in. (4.65 m)	15 ft. 3 in. (4.65 m)
N	Bucket Rotation	190 deg.	190 deg.	190 deg.
O	Transport Height	13 ft. 8 in. (4.17 m)	13 ft. 10 in. (4.22 m)	13 ft. 10 in. (4.22 m)

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1.6.0 Loaders—Compact Rubber Tire

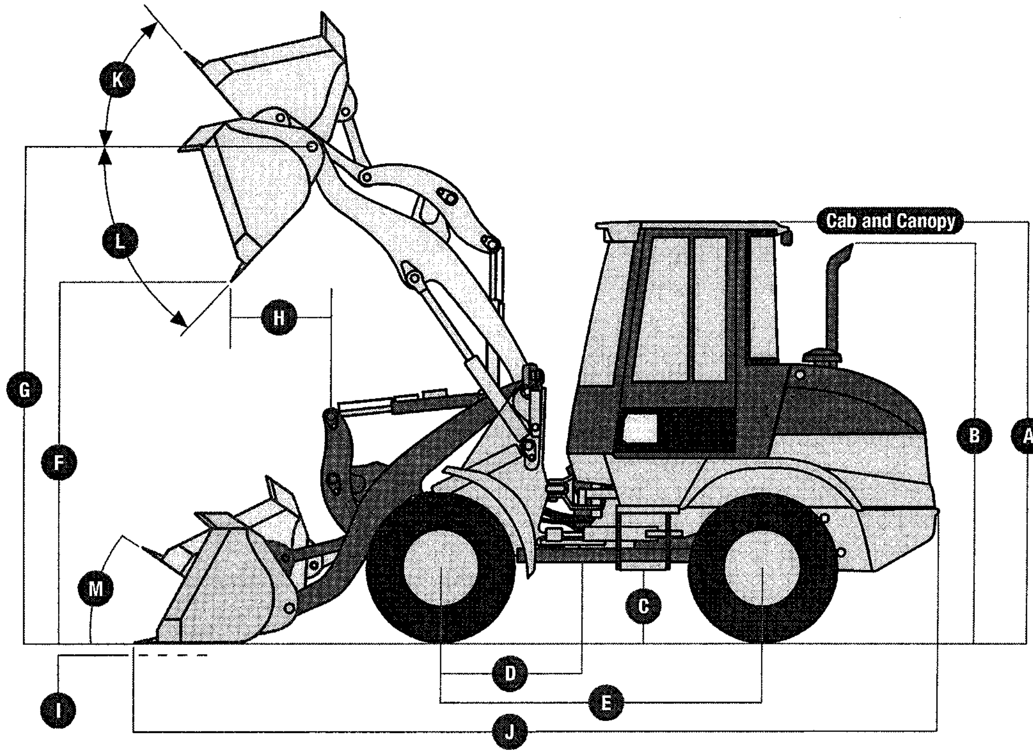
with 1.0 yd^3 (0.7646 m^3) bucket.

Hydraulic System/Steering

Pump (loader and steering)	fixed-displacement gear pump; open-center system
Maximum Flow @ 2,800 rpm	17 gpm (64.4 L/min.) @ 1,000 psi (6895 kPa)
System Relief Pressure	
Loader	3,190 psi (22 000 kPa)
Steering	2,611 psi (18 000 kPa)
Loader Controls	pilot-operated three-function valve with single-lever control for boom and bucket, and auxiliary lever for standard pin disconnect and auxiliary hydraulics, with control-lever lockout feature; optional additional four-function valve with push-button control
Steering (conforms to SAE J1511)	
Type	power, fully hydraulic
Articulation Angle/Rear Wheel Steering Angle	56-deg. arc (28 deg. each direction), plus 26 deg. rear wheel steering tied mechanically to articulation; equivalent of 97-deg. conventional steering system articulation
Hydraulic Cycle Times	
Raise	4.9 sec.
Dump	1.4 sec.
Lower	4.0 sec. (float down) / 3.6 sec. (power down)
Total	9.9 sec.
Maximum Lift Capacity	*with 1.0-cu.-yd. (0.8 m^3) bucket with bolt-on edge*
Lift at Ground Level	9,892 lb. (4487 kg)
Lift at Maximum Height	6,407 lb. (2906 kg)
Turning Radius (measured to centerline of outside tire)	11 ft. 6 in. (3505 mm)

Dimensions with Quick-Coupler/Bucket

A Height to Top of Cab and Canopy	8 ft. 11 in. (2725 mm)
B Height to Top of Exhaust	8 ft. 6 in. (2600 mm)
C Ground Clearance	11.6 in. (295 mm)
D Length from Center of Front Axle	29.5 in. (750 mm)
E Wheelbase	84.6 in. (2150 mm)
F Dump Clearance	▲ (see page 4)
G Height to Hinge Pin, Fully Raised	10 ft. 6.4 in. (3211 mm)
H Dump Reach at Full Height	▲▲ (see page 4)
I Maximum Digging Depth	3.1 in. (80 mm)
J Overall Length	▲▲▲ (see page 4)
K Maximum Rollback at Full Height	52 deg.
L Bucket Dump at Full Height	42 deg.
M Maximum Rollback at Ground Level	39 deg.



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1.6.1 Loaders—Mid-capacity Rubber Tire

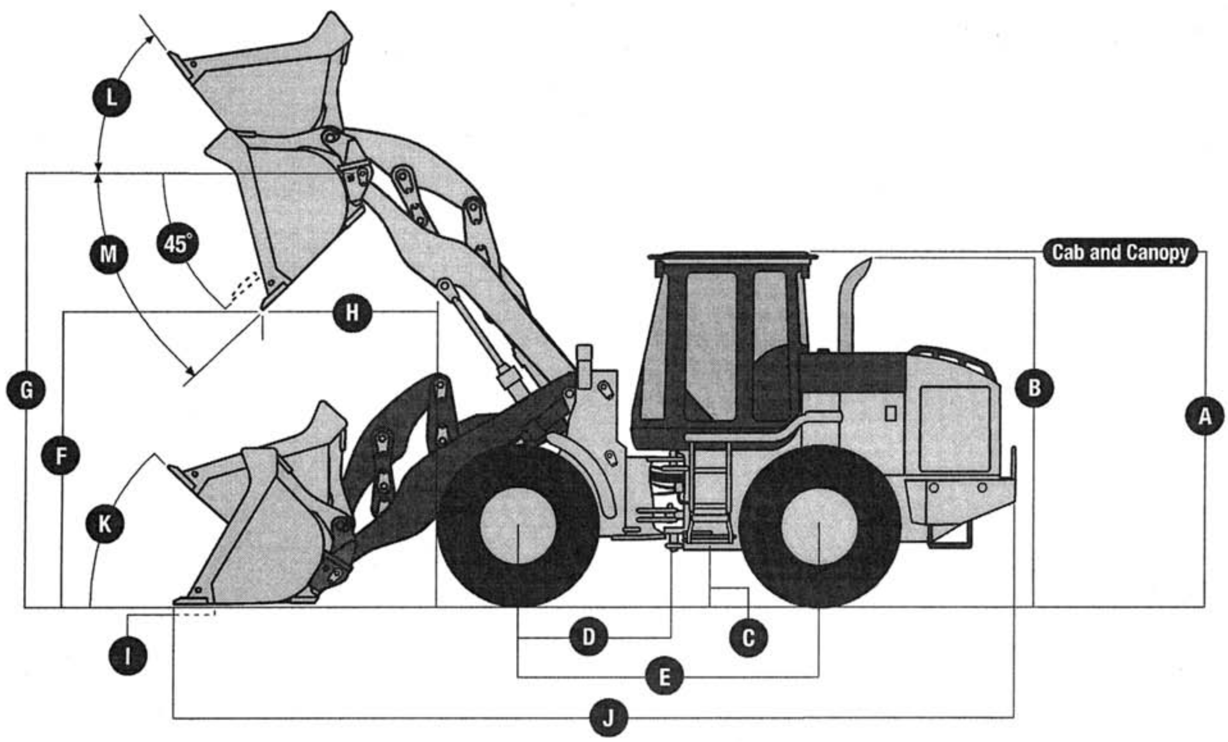
Loader with 2.5 yd^3 (1.9 m^3) bucket.

Hydraulic System/Steering

Pump (loader and steering)	variable-displacement, axial-piston pump; closed-center, pressure-compensating system
Maximum Rated Flow	37 gpm (140 L/m) @ 1,000 psi (6895 kPa)
System Relief Pressure (loader and steering)	3,600 psi (24 821 kPa)
Loader Controls	two-function valve; single- or dual-lever controls; control lever lockout feature; optional third- and fourth-function valve with auxiliary lever
Steering (conforms to SAE J1511)	
Type	power, fully hydraulic
Articulation Angle	80-deg. arc (40 deg. each direction)
Hydraulic Cycle Times	
Raise	5.5 sec.
Dump	1.1 sec.
Lower (float down)	1.9 sec.
Total	8.5 sec.
Maximum Lift Capacity	*with 2.0-cu.-yd. (1.5 m^3) general-purpose bucket with bolt-on edge*
Lift at Ground Level	23,412 lb. (10 620 kg)
Turning Radius (measured to centerline of outside tire)	15 ft. 5 in. (4.70 m)

Dimensions with Quick-Coupler and Hook-On Bucket

A	Height to Top of Cab and Canopy	10 ft. 5 in. (3.15 m)
B	Height to Top of Exhaust	10 ft. 4 in. (3.14 m)
C	Ground Clearance	15.6 in. (396 mm)
D	Length from Centerline to Front Axle	4 ft. 6 in. (1.38 m)
E	Wheelbase	9 ft. 0 in. (2.75 m)
F	Dump Clearance	(see page 4
G	Height to Hinge Pin, Fully Raised	12 ft. 0 in. (3.66 m)
H	Dump Reach	(see page 4)
I	Maximum Digging Depth	4.8 in. (122 mm)
J	Overall Length	(see page 4)
K	Maximum Rollback at Ground Level	41 deg.
L	Maximum Rollback, Boom Fully Raised	48 deg.
M	Maximum Bucket Angle, Fully Raised	50 deg.



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