Figure 34-1. The cylinder block usually extends from the oil pan rails at the bottom to the deck surface at the top.

Figure 34-2. An expansion (core) plug is used to block the opening in the cylinder head or block the holes where the core sand was removed after the part was cast.
Figure 34-3 A Styrofoam casting mold used to make the five cylinder engine blocks for the Chevrolet Colorado and the Hummer H3. The brown lines are glue used to hold the various parts together. Sand is packed around the mold and molten aluminum is poured into the sand which instantly vaporizes the Styrofoam. The aluminum then flows and fills the area of the mold.

Figure 34-4 Cast-iron dry sleeves are used in aluminum blocks to provide a hard surface for the rings.

FREQUENTLY ASKED QUESTION: What Is Compacted Graphite Iron?
Compacted graphite iron (CGI) has increased the strength, ductility, toughness, and stiffness compared to gray iron. If no magnesium is added, the iron will form gray iron when cooled, with the graphite present in flake form. If a very small amount of magnesium is added, more and more of the sulfur and oxygen form in the molten solution, and the shape of the graphite begins to change to compacted graphite forms. Compacted graphite iron is used for bedplates and many diesel engine blocks. It has higher strength, stiffness, and toughness than gray iron. The enhanced strength has been shown to permit reduced weight while still reducing noise, vibration, and harshness. Compacted graphite iron is commonly used in the blocks of diesel and some high-performance engines.
A dry sleeve is supported by the surrounding cylinder block. A wet sleeve must be thicker to be able to withstand combustion pressures without total support from the block.

A bedplate is a structural part of the engine which is attached between the block and the oil pan and supports the crankshaft.

FREQUENTLY ASKED QUESTION

What Are FRM-Lined Cylinders?

Fiber-reinforced matrix (FRM) is used to strengthen cylinder walls in some Honda/Acura engines. FRM is a ceramic material similar to that used to construct the insulators of spark plugs. The lightweight material has excellent wear resistance and good heat transfer properties, making it ideal for use as a cylinder material. FRM inserts are placed in the mold and the engine block is cast over them. The inserts are rough and can easily adhere to the engine block. The inserts are then bored and honed to form the finished cylinders. FRM blocks were first used in a production engine on the Honda S2000 and are also used on the turbocharged Acura RDX sport utility vehicle.
Figure 34-7  Casting numbers identify the block.

Figure 34-8  The deck is the machined top surface of the block.

Figure 34-9  Cutaway of a Chevrolet V-8 block showing all of the internal passages.
Figure 34-10 Typical oil gallery plugs on the rear of a Chevrolet small block V-8 engine.

OIL GALLERY PLUGS

CAMSHAFT CUP PLUG

TECH TIP: What Does LHD Mean?
The abbreviation LHD means left-hand dipstick, which is commonly used by rebuilders and remanufacturers in describing Chevrolet small block V-8 engines. Prior to about 1980, small block Chevrolet V-8s used a left-hand dipstick pad on the left side (driver’s side) of the engine block. Starting about 1980, however, dipstick pads on small block engines were relocated to the right side of the block. Therefore, to be assured of assembling or delivering the correct engine, knowing the dipstick location is critical. An LHD block cannot be used with the exhaust manifold setup that includes the oxygen sensor, which is currently used on these engines. Typically, the oxygen sensor is located on the passenger side of the engine. Small block cars with the dipstick pad on the left side were, therefore, coded as left-hand dipstick (LHD) engines.

NOTE: Some blocks cast around the year 1980 are cast with both right- and left-hand oil dipstick pads, but only one is drilled for the dipstick tube. SEE Figure 34–11.

Figure 34-11 Small block Chevrolet block. Note the left-hand dipstick hole and a pad cast for a right-hand dipstick.
Figure 34-12  Two-bolt main bearing caps provide adequate bottom end strength for most engines.

Figure 34-13  High-performance and truck engines often use four-bolt main bearing caps for greater durability.

Figure 34-14  Some engines add to the strength of a four-bolt main bearing cap by also using cross bolts through the bolts on the sides of the main bearing caps.
Figure 34-15 A girdle is used to tie all of the main bearing caps together.

Figure 34-16 The main bearing bores of a warped block usually bend into a bowed shape. The greatest distortion is in the center bores.

Figure 34-17 When the main bearing caps bow downward, they also pinch in at the parting line.
Figure 34-18 The main bearing bore alignment can be checked using a precision straightedge and a feeler gauge.

**FREQUENTLY ASKED QUESTION**

What Is a Seasoned Engine?

A new engine is machined and assembled within a few hours after the heads and block are cast from melted iron. Newly cast parts have internal stresses within the metal. The stress results from the different thickness of the metal sections in the head. Forces from combustion in the engine, plus continued heating and cooling, gradually relieve these stresses. By the time the engine has accumulated 20,000 to 30,000 miles (32,000 to 48,000 km), the stresses have been completely relieved. This is why some engine builders prefer to work with used heads and blocks that are stress relieved. Used engines are often called "seasoned" because of the reduced stress and movement these components have as compared with new parts.

Figure 34-19 (a) A precision arbor can be used to check the main bearing bore alignment.
Figure 34-19 (b) If the sleeve can be inserted into all of the main bearing bores, then they are aligned.

Figure 34-20 (a) Checking the flatness of the block deck surface using a straightedge and a feeler gauge.

Figure 34-20 (b) To be sure that the top of the block is flat, check the block in six locations as shown.
Figure 34-21  Grinding the deck surface of the block.

Figure 34-22  Cylinders wear in a taper, with most of the wear occurring at the top of the cylinder because of the greatest amount of heat and pressure found there. The ridge is formed because the very top part of the cylinder is not contacted by the rings.

Figure 34-23  Using a dial bore gauge to measure the bore diameter at the top just below the ridge (maximum wear section) and at the bottom below the ring travel (minimum wear section). The difference between these two measurements is the amount of cylinder taper. Take the measurements in line with the crankshaft and then repeat the measurements at right angles to the centerline of the block in each cylinder to determine out-of-round.
A cylinder boring machine is used to enlarge cylinder bore diameter so a
replacement oversize piston can be used to restore a worn engine to useful service or to increase
the displacement of the engine in an effort to increase power output.

A dry cylinder sleeve can also be installed in a cast-iron block to repair a worn or
cracked cylinder.

FREQUENTLY ASKED QUESTION
How Do I Determine What Oversize Bore Is Needed?
An easy way to calculate oversize piston size is to deter-
mine the amount of taper, double it, and add 0.010 in.
(Taper \times 2 + 0.010 in. = Oversize piston). Common
oversize measurements include:
• 0.020 in.
• 0.030 in.
• 0.040 in.
• 0.060 in.
Use caution when boring for an oversize measure-
ment larger than 0.030 in. due to potential engine damage
caued from too thin cylinder walls.
FREQUENTLY ASKED QUESTION

What Is a Boring Hone?
Many shops now use “boring” hones instead of boring bars. Boring hones have the advantages of being able to resize and finish hone with only one machine setup. Often a diamond hone is used and rough honed to within about 0.003 in. of the finished bore size. Then a finish hone is used to provide the proper surface finish.

Figure 34-26: An assortment of ball-type deglazing hones. This type of hone does not straighten wavy cylinder walls.

Figure 34-27: After boring, the cylinder surface is rough, pitted, and fractured to a depth of about 0.001 in.
Figure 34-28  Honing enlarges the cylinder bore to the final size and leaves a plateau surface finish that retains oil.

TECH TIP: Always Use Torque Plates

Torque plates are thick metal plates that are bolted to the cylinder block to duplicate the forces on the block that occur when the cylinder head is installed. Even though not all machine shops use torque plates during the boring operation, the use of torque plates during the final dimensional honing operation is beneficial. Without torque plates, cylinders can become out-of-round (up to 0.003 in.) and distorted when the cylinder heads are installed and torqued down. Even though the use of torque plates does not eliminate all distortion, their use helps to ensure a truer cylinder dimension. □ SEE FIGURE 34–29.  

Figure 34-29  A torque plate being used during a cylinder honing operation. The thick piece of metal is bolted to the block and simulates the forces exerted on the block by the head bolts when the cylinder head is installed.
The crosshatched pattern helps oil to keep the rings from wearing excessively, and also keeps the rings against the cylinder wall for a gas-tight fit.

**TECH TIP: Bore to Size, Hone for Clearance**

Many engine rebuilders and remanufacturers bore the cylinders to the exact size of the oversize pistons that are to be used. After the block is bored to a standard oversize measurement, the cylinder is honed. The rigid hone stones, along with an experienced operator, can increase the bore size by 0.001 to 0.003 in. (one to three thousandths of an inch) for the typical clearance needed between the piston and the cylinder walls.

For example:
- Actual piston diameter = 4.028 in.
- Bore diameter = 4.028 in.
- Diameter after honing = 4.030 in.
- Amount removed by honing = 0.002 in.

**NOTE:** The minimum amount recommended to be removed by honing is 0.002 in., to remove the fractured metal in the cylinder wall caused by boring.

**Chart 34-1**

<table>
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<th>Grit Size (G)</th>
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<th>Diameter (in.)</th>
<th>Diameter (mm)</th>
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<td>3.66</td>
</tr>
</tbody>
</table>
Figure 34-31 (a) The surface finish tool is being held against the cylinder wall.

Figure 34-31 (b) The reading indicates the Ra roughness of the cylinder. More work is needed if moly piston rings are to be used.

Figure 34-32 Using a tapered sanding cone to remove the sharp edges at the top of the cylinders shaped when the block was machined.
TECH TIP: Install Lifter Bore Bushings

Lifter bores in a block can be out-of-square with the camshaft, resulting in premature camshaft wear and variations in the valve timing from cylinder to cylinder. To correct for this variation, the lifter bores are bored and reamed oversize using a fixture fastened to the block deck to ensure proper alignment. Bronze lifter bushings are then installed and finish honed to achieve the correct lifter-to-bore clearance. **SEE FIGURE 34-33.**

The lifter bores should be "honed" with a ball-type hone. This should be done even if they are "in-line" and do not need bushings. This is often overlooked by technicians and can lead to lifter problems later on, causing lifters to stick on the bores.

Figure 34-33  High-performance engine builders will often install bronze sleeves in the lifter bores.

Figure 34-34  Notice on this cutaway engine block that some of the head bolt holes do not extend far into the block, and dead-end. Debris can accumulate at the bottom of these holes and it must be cleaned out before final assembly.
Figure 34-35 A thread chaser or bottoming tap should be used in all threaded holes before assembling the engine.