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## Field of play and equipment for baseball game: An overview

**Singh Tribhuvan Jogendra and Dr. Sandeep Bhalla**

### Abstract

Baseball is a game in which there are batting and pitching. Two teams can play this game. It is a field game that is played with bats and a ball between two teams. In this sport, the player should hit the ball that throws the pitcher and then to run the field in the clockwise, i.e., to run through the four bases that are marked on the field. The goal of baseball is to prevent a player from the rival team from reaching the base, i.e., hitting the ball. The two teams each have nine players. One team take the offensive, that is the batting and running, while the other team takes the defensive position that is pitching- throwing the ball and defending. The pitch is in the shape of a diamond with four 'bases' – first, second, third and fourth base. Four players from the offensive team are present on the pitch at one base each. The player in the batting position hits the pitched ball and runs to the second base while the players at the other bases also move to the next base in an anti-clockwise direction to make runs. The other team tries to get the players out. Once three of the offensive players get 'out' the other team comes in to bat. A match has nine innings, each of which is one turn of batting and one with the ball for each team. The aim of the offensive team to make as many runs as possible without getting out. The defensive team tries to get as many players from the offensive as possible while defending the pitch.

**Keywords:** Baseball, batting, pitching, running, teams, ball, bat, field, innings, runs

### Introduction

The baseball traces its origin to the game of the same name. Modern baseball evolved from the English game of "rounders" in the first half of the 19th century. Alexander Cartwright of New York formulated the basic rules of baseball in 1845, calling for the replacement of the soft ball used in rounders with a smaller hard ball. Despite its uncomplicated appearance, the baseball is in fact a precision-made object, and one that has often been the subject of heated controversy throughout its history. Although baseballs have changed very little in this century, either in terms of their physical dimensions or raw materials, some observers have suggested that the balls have secretly been "juiced up" to increase the output of crowd-pleasing homeruns during periods of lagging attendance at major league baseball games. The manufacturers of baseballs and Major League Baseball have steadfastly denied such allegations, however, and no proof of any covert alterations in the ball's design or composition has ever been produced. An official Major League baseball consists of a round cushioned cork center called a "pill," wrapped tightly in windings of wool and polyester/cotton yarn and covered by stitched cowhide. Approximately 600,000 baseballs are used by all Major League teams combined during the course of a season. The average baseball remains in play for only five to seven pitches in a Major League game. Each ball must weigh between 5 and 5.25 ounces (141.75-148.83 grams) and measure between 9 and 9.25 inches (22.86-23.49 centimeters) in circumference to conform to Major League standards.

Such uniformity was non-existent in the early years of baseball's history, when balls were either homemade or produced on a custom-order basis as a side line by cobblers, tanners and other small business owners. In 1872, the modern standard for the baseball's weight and size was established. The production of balls became more consistent during the remainder of the decade, thanks largely to the demands made on manufacturers by the newly formed National League, the first professional baseball league.

At the turn of the century, the baseball had a round rubber core. This gave way in 1910 to the livelier cork-centered ball, which was itself replaced two decades later by the even more

resilient cushioned cork model. The baseball has undergone only one significant change since that time, when a shortage in the supply of horses in 1974 prompted a switch from horsehide to cowhide covers.

### Raw Materials Used in Baseball

A baseball has three basic parts: the round cushioned cork pill at its core, the wool and poly/cotton windings in its midsection, and the cowhide covering that makes up its exterior. The pill consists of a sphere, measuring 13/16 of an inch (2.06 centimeters) in diameter, made of a cork and rubber composition material. This sphere is encased in two layers of rubber, a black inner layer and a red outer layer. The inner layer is made up of two hemispheric shells of black rubber that are joined by red rubber washers. The entire pill measures 4-1/8 inches (10.47 centimeters) in circumference. There are four distinct layers of wool and poly/cotton windings that surround the cushioned cork pill in concentric circles of varying thickness. The first winding is made of four-ply grey woollen yarn, the second of three-ply white woollen yarn, the third of three-ply grey woollen yarn, and the fourth of white poly/cotton finishing yarn. The first layer of wool is by far the thickest. When wrapped tightly around the pill, it brings the circumference of the unfinished ball to 7-3/4 inches (19.68 centimeters). The circumference increases to 8-3/16 inches (20.77 centimeters) after the second winding has been applied, 8-3/4 inches (22.22 centimeters) after the third, and 8-9/16 inches (22.52 centimeters) after the fourth. Wool was selected as the primary material for the baseball's windings because its natural resiliency and "memory" allow it to compress when pressure is applied, then rapidly return to its original shape. This property makes it possible for the baseball to retain its perfect roundness despite being hit repeatedly during a game. A poly/cotton blend was selected for the outer winding to provide added strength and reduce the risk of tears when the ball's cowhide cover is applied. The baseball's outer cover is made of Number One Grade, alum-tanned full-grained cowhide, primarily from Midwest Holstein cattle. Midwest Holsteins are preferred because their hides have a better grain and are cleaner and smoother than those of cattle in other areas of the United States. The cover of an official baseball must be white, and it must be stitched together with 88 inches (223.52 centimeters) of waxed red thread. Cowhides are tested for 17 potential deficiencies in thickness, grain strength, tensile strength and other areas before they are approved for use on official Major League baseballs.

### Manufacturing Balls Used in Baseball

#### • Process

The production of a baseball can be viewed as a process of placing successive layers of material (rubber, fabric and cowhide) around a rubbery sphere not much bigger than a cherry. These materials are placed around the small sphere in three distinct ways: the rubber is moulded, the fabric is wound, and the cowhide is sewn. The placement of materials around the sphere is done under carefully controlled conditions to ensure that consistent size, shape and quality are maintained. An advertisement for baseballs from the hade catalogue of Horace, Partridge & Co., from about 1891. An advertisement for baseballs from the hade catalogue of Horace, Partridge & Co., from about 1891. Baseball," wrote Mark Twain (Samuel L. Clemens), "is the very symbol, the outward and visible expression of the drive and push and rush and struggle of the raging, tearing, booming nineteenth

century." Baseball initially evolved into a favourite American sport because it was faster paced and more physical than its English predecessors, cricket, town-ball, and rounders. Though cricket was played wherever English immigrants congregated in the United States, Americans seemed to prefer the more aggressive character of baseball. Initially played by gentlemen in fashionable clothing, the game and its equipment—and its popularity—began to change once rules were written down in the 1840s. In particular, the game gained tremendous popularity after the Civil War. The ball itself was changed at least twice in that century: the first ball was too lively (scores sometimes exceeded 100 runs); the second was too dead (a scoreless 24-inning game convinced many that hitters were disadvantaged). A. G. Spalding made headline news in 1888-89 when he led a widely popular tour of American baseball players that played demonstration games in countries around the world. By the turn of the century, Spalding was marketing four baseballs in boy's size and eight in regulation size, each costing from four cents to one dollar.

### Moulding Rubber Used in Manufacturing Balls for Baseball

Two hemispheric shells of black rubber, each approximately 5/3 of an inch (.39 centimeter) thick, are moulded to a sphere of rubberized cork measuring 1/2 of an inch (2.06 centimeters) in diameter. The two small openings that separate these shells are sealed with red rubber gaskets. The first step in manufacturing a baseball involves moulding two shells of black rubber to a rubberized cork. After a thin layer of red rubber is moulded to the ball and a layer of cement is applied, wool yarn is wound around the ball. The yarn is wound in three layers: four-ply grey yarn, followed by three-ply white yarn, and finally three-ply grey yarn. A final layer of poly/cotton finishing yarn is next wrapped around the ball. The final layer is the cowhide cover, consisting of two figure-eight pieces that are stapled to the ball and then stitched together. The first step in manufacturing a baseball involves moulding two shells of black rubber to a rubberized cork. After a thin layer of red rubber is moulded to the ball and a layer of cement is applied, wool yarn is wound around the ball. The yarn is wound in three layers: four-ply grey yarn, followed by three-ply white yarn, and finally three-ply grey yarn. A final layer of poly/cotton finishing yarn is next wrapped around the ball. The final layer is the cowhide cover, consisting of two figure-eight pieces that are stapled to the ball and then stitched together. Next, a layer of red rubber roughly 3/32 of an inch (.24 centimeter) thick is moulded to the black rubber encasement. The entire "pill" is then moulded into a perfect circle weighing approximately 7/8 of an ounce (24.80 grams) with a circumference of roughly 4-1/8 inches (10.48 centimeters). Once the pill has been moulded, a thin layer of cement is applied to its surface. This layer keeps the wool yarn in place on the pill at the start of the first winding operation.

#### • Winding Fabric in Balls Used in Baseball

Wool yarn, stored under controlled fabric temperature and humidity conditions, is wound around the pill. This is done by computerized winding machines that maintain a constant level of very high tension to eliminate "soft spots," and create a uniform surface. After each step in the winding process, the ball is weighed and measured by computer to assure that official size requirements have been met. The wool yarn is wound so tightly that it has the appearance of thread when a

baseball is dissected. Three layers of wool are wound around the baseball: the first, 121 yards (110.6 meters) of four-ply grey yarn; the second, 45 yards (41.13 meters) of three-ply white; and the third, 53 yards (48.44 meters) of three-ply grey. A layer of 150 yards (137.1 meters) of fine poly/cotton finishing yarn is wrapped around the ball to protect the wool yarn and hold it in place. The wound ball is then trimmed of any excess fabric and prepared for the application of the external cowhide covering by being dipped in an adhesive solution.

#### • Sewing Hide

5 The cowhide covering is cut into two figure-8 patterns. Each pattern covers half the wound ball. Before they are stitched to the wound ball, the cowhide coverings are dampened to increase their pliability. The insides of the coverings also receive a coating of the same adhesive that was applied to the wound ball. The two figure-8 coverings are stapled to the wound ball, then they are hand-sewn together using 88 inches (223.52 centimeters) of waxed red thread. There are 108 stitches in the sewing process, with the first and last completely hidden. An average of 13 to 14 minutes is required to hand-sew a baseball. After the covers have been stitched together, the staples are removed, and the ball is inspected. The ball is then placed in a rolling machine for 15 seconds to level any raised stitches. The baseballs are then measured, weighed and graded for appearance. Acceptable baseballs are stamped with the manufacturer's trademark and league designation.

#### Quality Control

A statistically representative sample of each shipment of baseballs is tested to measure Co-Efficient of Restitution (COR), using Major League Baseball's officially sanctioned testing procedures. Essentially, the COR is an indication of the resiliency of a baseball. The COR test involves shooting a baseball from an air cannon at a velocity of 85-feet-a-second (25.90-meters-a-second) at a wooden wall from a distance of eight feet (2.43 meters) and measuring the speed with which the ball rebounds off the wall. Major League COR specifications stipulate that a baseball must rebound at 54.6 percent of the initial velocity, plus or minus 3.2 percent. A baseball must also retain its round shape after being hit 200 times by a 65-pound (29.51 kilograms) force. As proof of its strength, a baseball must distort less than 0.08 of an inch (.20 centimeter) after being compressed between two anvils.

In sum, the size of baseballs and the raw materials used to make them are likely to remain unchanged in the foreseeable future. Also, a finished baseball, with 88 inches of waxed red thread holding the two cowhide covering pieces together, weighs between 5 and 5.25 ounces and measures between 9 and 9.25 inches in circumference. A finished baseball, with 88 inches of waxed red thread holding the two cowhide covering pieces together, weighs between 5 and 5.25 ounces and measures between 9 and 9.25 inches in circumference.

Few, if any, changes are expected in the process by which baseballs are manufactured.

Attempts have been made to automate the process of sewing cowhide covers on baseballs, but none has been successful. Automated machines that have been experimented with have exhibited two serious problems: first, they have been unable to start or stop the stitching process without manual assistance; and second, they have been unable to vary the tension of their stitches, something that is essential if the two figure-8 coverings are to fit securely on the wound ball

without tearing. It is also probable that the controversy about juiced-up balls will continue as long as the game of baseball is played, and fans seek an explanation for fluctuations in the homerun output of favourite teams and players <sup>[1]</sup>.

#### Field of Play

**A. Grounds:** In major league playing fields, the distance to the fence from home plate along the foul lines (marking the official limits of the playing field) must be 250 feet (76.2 metres) or more. For fields built after 1958, however, the distance along the foul lines should be at least 320 feet (98 metres), and the distance from home plate on a line through second base to the centre-field fence should be at least 400 feet (121.9 metres). The distance to the stands or fence behind home plate should be at least 60 feet (18.3 metres) but may taper off along the foul lines in the outfield. Coaches' boxes are in foul territory behind first and third base. On-deck circles, where the next batter up in the lineup waits for his turn at bat, are near the team benches. The playing field is traditionally covered with grass, except for the pitcher's circle, or mound, the base paths, the adjacent infield from first to third base, and the home plate area. The use of an artificial turf, first known as astro turf, was commonplace in the 1970s and '80s, and it is still used in some stadiums. Artificial turf fields are typically covered entirely by the turf, except for dirt areas around the pitcher's plate, home plate, and the bases. Because of the hardness of the artificial turf surface, play on such fields is very fast and balls bounce much higher than on natural grass. New types of artificial turf introduced in the late 1990s offered a softer, more grass like experience and incorporated the dirt infield found on natural grass fields. Canvas bags filled with soft material and attached to metal stakes driven into the ground mark first, second, and third base. Home plate is a flat, pentagonal, white slab of rubber embedded flush in the ground.

**B. Umpires:** Umpires control the game. One behind home plate calls balls and strikes on the batter, determines whether a batter has been hit by a pitch or has interfered with the catcher (or vice versa), and calls runners safe or out at home plate. He and the other three umpires, stationed near first, second, and third base, may call hit balls foul (beyond the foul lines) or fair (or within the foul lines); the other three call runners safe or out at the first three bases. Any umpire may call an illegal pitching motion known as a balk. An umpire may ask for help from his fellow umpires if he was out of position to see a play, and the first- or third-base umpire may be appealed to concerning whether a batter has taken a full swing for a strike call or instead checked his swing.

#### Equipment

**A. The Ball and Bat:** The ball has a cork-and-rubber core, around which yarn is tightly wrapped; the cover consists of two snugly fitted pieces of white leather sewn together. The circumference is 9 to 9.25 inches (23 to 23.5 cm) and the weight between 5 and 5.25 ounces (142 and 149 grams). The bat is a smooth rounded stick of solid or laminated wood, not longer than 42 inches (107 cm) or thicker at the barrel end than 2.75 inches (7 cm), tapering to the handle end. (Usually, however, in major league baseball, players prefer a bat no longer than 35 inches [89 cm] that weighs about 30 ounces [850 grams] or less) There is no weight restriction on the bat, but no

metal or other reinforcement can be used in construction of the bat. (Amateur players, however, are permitted to use aluminum bats.) The handle may have tape and adhesive material, such as pine tar, applied to it to improve the grip (but such substances may not be applied more than 18 inches [46 cm] from the tip of the handle in major league play).

- B. Gloves:** Baseball was originally played bare-handed. Beginning in 1860, catchers, who attempt to catch every pitch not hit, became the first to adopt gloves. First basemen, who take many throws for putouts from the infielders, soon followed, and finally all players adopted gloves. All gloves are constructed of leather with some padding. The catcher's glove, or mitt, presents a solid face except for a cleft between the thumb and index finger and is thickly padded except at the centre, where the pitched ball is caught. The glove cannot exceed 38 inches (96.5 cm) in circumference and 15.5 inches (39.4 cm) from top to bottom. The first baseman's glove is thinner and more flexible, a solid expanse of leather for the four fingers with a webbing connecting the thumb and index finger. All other players' gloves are finger gloves with leather straps connecting the thumb and index finger.
- C. Protective Gear:** The catcher wears a helmet, a barred mask with a hanging throat guard, a padded chest protector, and lightweight guards covering the knees, shins, and ankles. The umpire behind home plate wears a similar chest protector and mask. At bat players wear a lightweight plastic batting helmet that flares down over the ears to protect the temples. Groin protection is also worn by male players.

So, one needs very little equipment to play a baseball game. The essential pieces are nine gloves (one for each fielder), one ball, and one bat. The batter and catcher also require some special protective gear. The following is a list of some basic baseball equipment:

- a) **Ball:** An official baseball is manufactured through a process of wrapping yarn around a cork or rubber center and then tightly stitching a cowhide or horsehide cover over the yarn. A baseball is a sphere that is approximately 9 inches (23 cm) in circumference and weighs 5 1/4 ounces (149 g).
- b) **Bat:** A bat is a solid piece of wood, usually ash, that is 2.75 inches (7 cm) in diameter at the thickest part, which is called the barrel, and not more than 42 inches (107 cm) in length.
- c) **Batting Helmet:** A helmet protects a baseball player if a ball accidentally hits him in the head. Some pitchers can throw a baseball as fast as 100 miles per hour (161 kph), so a player needs to wear a helmet to prevent severe head injuries.
- d) **Batting Glove:** Although not a required piece of equipment, many batters wear gloves to protect their hands while batting. Blisters may be caused by not wearing batting gloves. Some players wear these gloves while running bases to protect their hands while sliding into bases.
- e) **Fielding Glove:** A glove may vary based on the player's position, but it is typically leather with a webbed pocket, which forms a small basket.
- f) **Cleats:** All ball players wear a particular type of shoe called cleats, which are defined by the spikes attached to the soles. Baseball cleats have spikes near the toe of the

shoe, which differentiates it from cleats in other sports.

- g) **Catcher's Equipment:** A catcher is the target for the pitcher, so the catcher must wear protective gear that covers the majority of his body. Catcher's gear includes a helmet with a faceguard that is similar to a hockey goalie's mask, a chest protector, shin guards, and a special padded glove. Some catchers also wear devices called knee savers, which are triangular pads that attach to the players calves and rest his knees even while squatting behind the plate <sup>[2]</sup>.

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