Core Properties

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The pure motion of a bowling ball is controlled primarily by two components, the core and shell. These components work together to determine the overall ball reaction. The composition of the shell determines the amount of friction between the ball and the lane, while the physical or mass properties of the core aid in the rotation of the ball as it rolls down the lane. To see how the two components compliment each other, let's first look at core properties using basic definitions and terminology.

The inner core of a bowling ball can be designed with a variety of shapes. The characteristics of the inner core's size, shape, and density play a vital role in determining how the core will influence the rotation of the bowling ball. To further understand how physical properties of the core influence ball reaction, the following two terms need to be defined and addressed:

1) Radius of Gyration
2) Differential Radius of Gyration

Technically speaking, the radius of gyration is defined as the square root of the moment of inertia divided by mass of the object. Therefore, the radius of gyration is the distance that, if the entire mass of the object were together at only that specific radius, would yield the same moment of inertia. The moment of inertia for an object is the ratio of applied torque and the resultant angular acceleration of the object. Translating the physics definition, the moment of inertia measures how easy an object will rotate when a force is applied. Thus, in simple terms, the radius of gyration determines how easy it is for the bowling ball of particular weight to rotate about a given axis and is a measurement of where the weight is located inside the ball, relative to the center. To help explain this term further, imagine a figure skater twirling on the ice. If the skater spins on the ice with arms extended out, the rate of rotation is slower than if the arms are pulled inward towards the body. The same physics principle applies for a designed core inside of the bowling ball. For a given core shape, the more dense (heavier) the inner core becomes, the more the bowling ball will simulate rotation like a figure skater with arms tucked close the body. In other words, the core will have a low RG and will help the ball rev up in a quick manner. The less dense (lighter) the inner core is, the more the ball will behave as a spinning figure skater with arms extended out and it will take longer for the ball to rev up as it travels down the lane, thus, having a higher RG. The low RG ball allows friction with the lane to add to rotation for a sooner and more arcing breakpoint. The high RG ball will resist rotation longer than the low RG and it becomes harder for friction to add to the ball's rotation, resulting in a ball that slides further down lane before hooking. The radius of gyration is measured in inches. The USBC has a lower limit of 2.43'' and an upper limit of 2.80''. More aggressive bowling balls on the market have an RG close to the lower limit, while plastic balls will have an RG value near the upper limit.

Every ball has a high RG axis and a low RG axis. For an example in terms of the figure skater, the high RG axis would be when the skater has arms out and the low RG axis is when the skater has arms in. It is the difference between the maximum and the minimum RG that is defined as the differential radius of gyration. To explain in greater detail, think of a football being thrown by a quarterback and kicked by a kicker. In these two scenarios the football rotates in two different manners. The shape of the football helps to determine which orientation the ball rotates in. When thrown, the football wants to rotate in a spiral and when kicked it rotates end over end. If not rotating in one of these two orientations, the ball will try to migrate towards one of the two “preferred spin axis”. Translating back to bowling, the maximum and minimum RG create a preferred spin axis on the bowling ball. When the bowling ball is released by the bowler, the ball will try to migrate towards the preferred spin axis as it rolls down lane. An indication of this principle can be seen by the oil rings on the ball. While the number of oil rings is a direct result of a bowlers RPM, a ball with a larger difference between the maximum and minimum RG values (Differential Radius of Gyration) will have greater separation between the oil rings. A small differential radius of gyration will have less separation and sometimes produce one thick oil band around the ball, due to the lack of a significant preferred spin axis. Simply defined, differential radius of gyration can be directly related to the flare potential of the bowling ball. Greater flare allows a greater portion of the bowling ball to contact the lane as the ball travels toward the pins. This is important because the fresh coverstock contacting the lane will have greater friction and allow the ball to hook more. Currently, USBC has limited the differential radius of gyration to .060’’.

Once understanding the two basic core properties, radius of gyration and differential radius of gyration, a designer can better relate the necessary core shape and density to yield the intended performance of the finished product. As mentioned before, core properties are only one key to bowling ball reaction and performance. Coverstocks and how to relate core to cover will be explained in the next article. If any of the above information is still “clear as mud”, please send an email to Nick.Siefers@bowl.com and any questions will be addressed.