FOCUS: Smash Factor (continued)

How does TrackMan[™] actually measure smash factor?

While the calculation of smash factor is simply the ratio between ball speed and club head speed, there are some details that are worth noticing. The ball speed is very well defined, and TrackMan™ measures the ball speed directly within 0.1 mph.

However, with the club head speed things are not quite as simple. It might be a surprise to many golfers, but the club head speed actually varies significantly depending on where on the club face you are looking. On average there is a 14% difference between heel and toe speed. This means that if you have 100 mph club head speed in the center of the club face, the speed of the heel will be around 93 mph and the toe 107 mph. This is primarily due to two things: 1) the further distance from grip to the toe of the club compared to the grip to heel 2) the rotation of the club head during the downswing. Likewise, the club head speed low on the club face is higher than high on the club face.

TrackMan[™] always refers to the club head speed at the center of the club face, but because of around a 3/8 inch uncertainty of the location of the radar reflection point on the back of the club face, this leads to an accuracy of the club head speed measurement of the TrackMan[™] of ±1 mph with reference to the center of the club face.



Figure 1: Typical club head speed variation across the club face.

Let me give you an example of how this affects your smash factor measurement: Let us assume a club head speed of 100 mph (in the center of the club face) with a dead center ball impact producing 148 mph ball speed. This should theoretically give a smash factor of 1.48. However, due to the uncertainty of the exact location of the club head speed reading of the TrackMan[™], the smash factor might be measured somewhere between 148/101 and 148/99 (1.465 to 1.495).

Let us then take the other case where the ball is impacted at the 5 different locations indicated on the club face above but having the club delivered with the same speed and spin loft to the ball (Figure 1).The club head measured by the TrackMan[™] is independent on where on the club face the ball is impacted, so this will be 100 mph for all the 5 different impact locations. In the table below, an example of a realistic variation of the COR variation across the club face has been used. Maximum ball speed is obtained with impact ³/₄ of an inch towards the toe despite the lower COR of 0.81 at this point on the club face.

IMPACT	CLUB SPEED [mph]	COR	BALL SPEED [mph]	TrackMan SMASH FACTOR	Theoretical SMASH FACTOR
1 CENTER	100.0	0.83	148.0	1.480	1,480
2 ¾" TOE	102.7	0.81	150.3	1.503	1,463
3 ¾" HEEL	97.3	0.81	142.4	1.424	1,463
4]½" HIGH	98.2	0.82	144.5	1.445	1.471
5 ½" LOW	101.8	0.82	149.8	1.498	1.471

Table 3: Smash factor variation across club face. Assuming no club head rotation due to off-center hits.

If the smash factor was calculated from straight theory (last column in table 3): ball speed divided with the club head speed at point of impact, the smash factor producing the highest 150.3 mph ball speed would come out as 1.463.

Since ball speed (together with launch angle and spin rate) is what matters for the ball flight, by using the center of the club face as reference for the club head speed measurement, maximizing your TrackMan[™] smash factor means also maximizing your ball speed for a given physical strength.

This means that in the case the ball is impacted towards the toe (higher club head speed) but still with a high COR and no loss of energy due to twisting of the club head during impact, the theoretical maximum smash factor might be 1.48, but the TrackMan[™] smash factor could come out higher.

Are there more smash factor discoveries left to make?

We have so far spent most of our time looking at smash factors for drivers. We have now started looking at smash factors for irons. The tour pros seem to generate a slightly higher smash factor with their irons, especially the shorter ones, than what you would expect from the loft of the club. So we are currently analyzing the tour pros' club delivery - in particular attack angle and dynamic loft to understand more precisely what the world's best ball strikers are doing. The results of this will be very valuable for both fitting and instruction.