ENGINEERING REPORT

Subject: Side Weight vs. Large Balance Holes

Date: 12/21/2017

Place: International Training & Research Center

Present: Tom Frenzel

Purpose:

Examine the performance characteristics of bowling balls with side weight outside of specifications compared to balls with large balance holes.

Summary:

Balls drilled with large balance holes tend to hook earlier than balls with large side weights.

Data:

Two balls from different brands were selected for this study that had large top weights and pin to center of gravity distances. First, the balls were thrown undrilled with their center of gravities shifted right of the grip center to give the ball three-ounces of side weight. Both balls were thrown on a typical house condition and then the 2017 USBC Masters pattern. The balls were thrown in alternating order with the same settings on E.A.R.L.:

Ball Speed	17.2 MPH
RPM	350 RPM
Axis Rotation	50 degrees
Axis Tilt	10 degrees
Laydown	22 board
Trajectory	-1.85 degrees

After the undrilled data with large side weights was collected, the balls were drilled with two finger holes and a thumb hole about the center of grip. They we also drilled with a large balance hole to get the balls back to legal static weights. The balance holes were also drilled to increase total differential as much as possible, but we were limited based on where the centers of gravity was located on each ball. The changes to the specifications of the bowling balls were recorded and then the balls were thrown again on the same two patterns.

ENGINEERING REPORT

Ball Data

When a bowling ball is drilled, the holes change the ball's mass properties. The mass properties include:

1. Total Weight (Mass)
2. Imbalance (Center of Volume to Center of Mass distance)
3. Thumb, Side, and Top Weight (imbalance components measured from the center of grip)
4. Moment of Inertia (X, Y, and Z)
5. Radius of Gyration (X, Y, and Z, RG is determined by weight and moment of inertia)

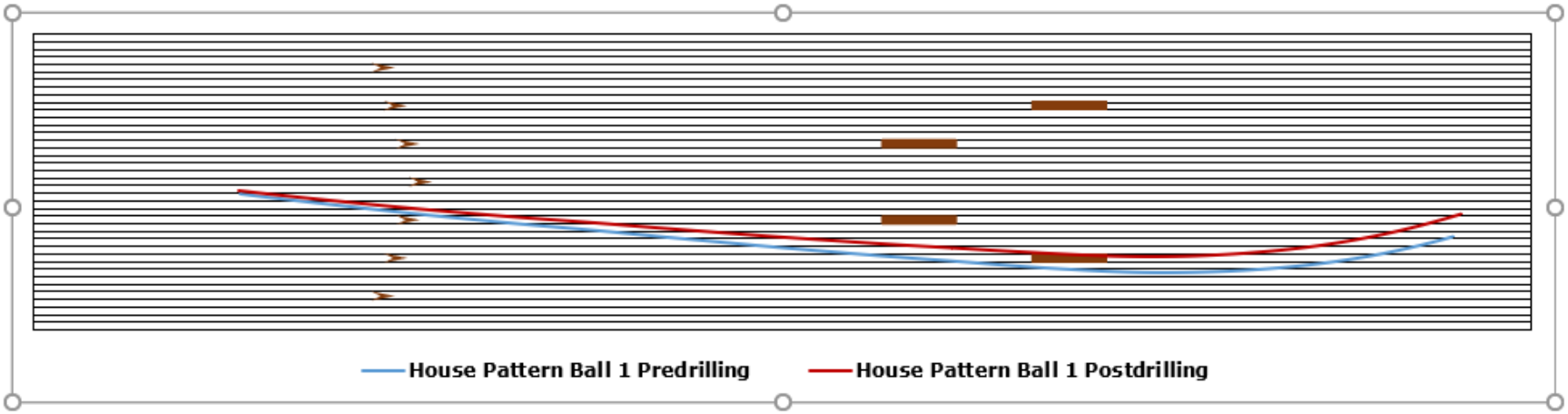
Below is a table that illustrates how the balls in this study were affected by the drilling process:

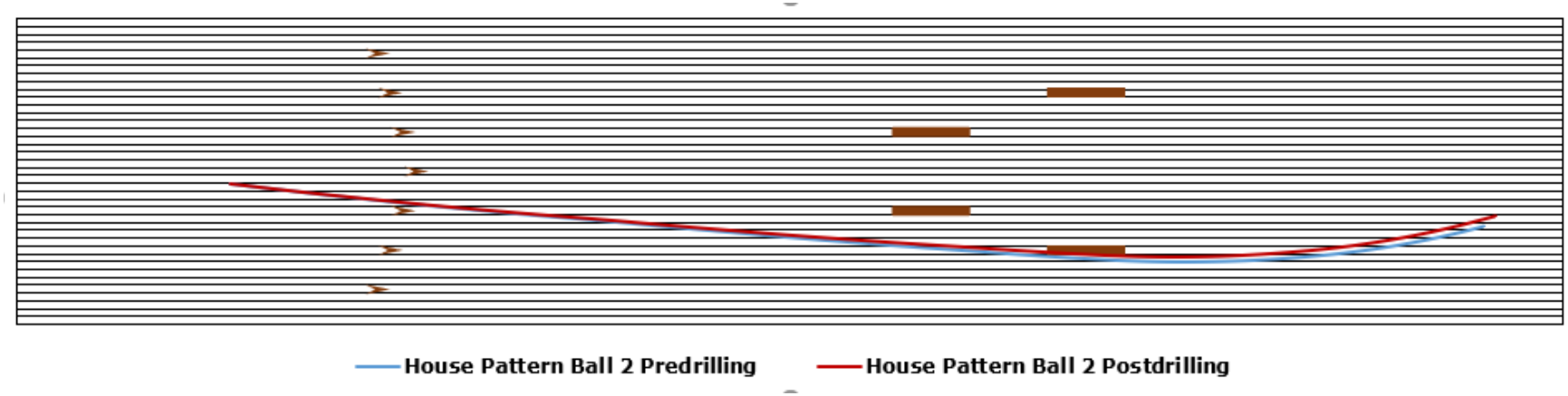
Ball	Type	Weight	Imbalance	Thumb	Side	Top	RGx	RGy	RGz	Ix	Iy	Iz	RG Total Differential	I Total Differential
1	Pre-drilling	15.185	4.100	0.000	3.021	2.772	2.481	2.536	2.533	93.5	97.7	97.4	0.055	4.2
1	Post-drilling	14.700	1.366	-1.025	0.900	-0.075	2.484	2.547	2.531	90.7	95.4	94.1	0.063	4.6
2	Pre-drilling	15.275	3.200	0.000	2.747	1.642	2.553	2.610	2.613	99.6	104.1	104.3	0.057	4.5
2	Post-drilling	14.830	1.931	-0.850	0.950	-1.450	2.562	2.627	2.615	97.4	102.3	101.4	0.065	5.0

ENGINEERING REPORT

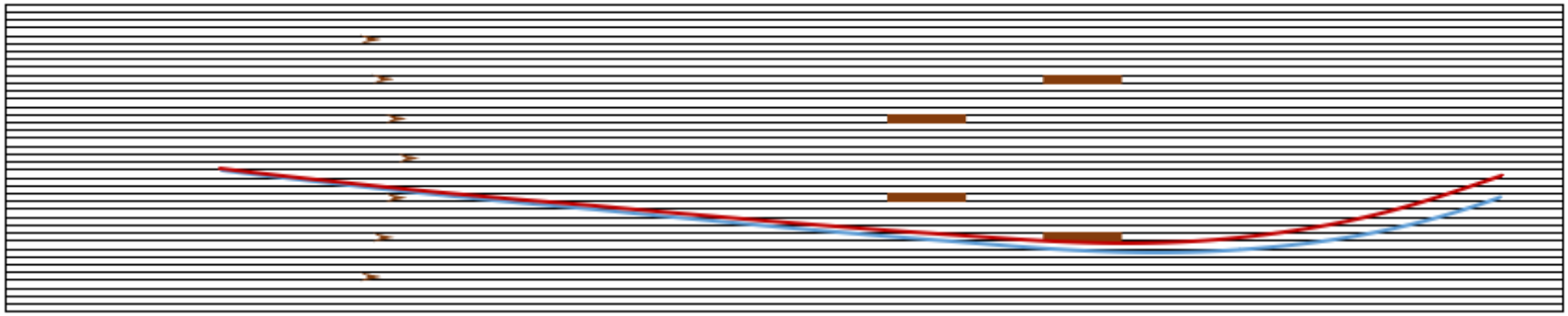
Ball	Ball Weight		Ball	Imbalance		Ball	Total Diff	
1			**1**			**1**		
Pre-drilling	15.185	**Change:**	Pre-drilling	4.100	**Change:**	Pre-drilling	0.055	**Change:**
Post-drilling	14.700	**-0.485**	Post-drilling	1.366	**-2.734**	Post-drilling	0.063	**0.008**
2			**2**			**2**		
Pre-drilling	15.275	**Change:**	Pre-drilling	3.200	**Change:**	Pre-drilling	0.057	**Change:**
Post-drilling	14.830	**-0.445**	Post-drilling	1.931	**-1.269**	Post-drilling	0.065	**0.008**
Ball	**Thumb Weight**		**Ball**	**Side Weight**		**Ball**	**Top Weight**	
1			**1**			**1**		
Pre-drilling	0.000	**Change:**	Pre-drilling	3.021	**Change:**	Pre-drilling	2.772	**Change:**
Post-drilling	-1.025	**-1.025**	Post-drilling	0.900	**-2.121**	Post-drilling	-0.075	**-2.847**
2			**2**			**2**		
Pre-drilling	0.000	**Change:**	Pre-drilling	2.747	**Change:**	Pre-drilling	1.642	**Change:**
Post-drilling	-0.850	**-0.850**	Post-drilling	0.950	**-1.797**	Post-drilling	-1.450	**-3.092**
Ball	**Low RG**		**Ball**	**High RG**		**Ball**	**Med RG**	
1			**1**			**1**		
Pre-drilling	2.481	**Change:**	Pre-drilling	2.536	**Change:**	Pre-drilling	2.533	**Change:**
Post-drilling	2.484	**0.003**	Post-drilling	2.547	**0.011**	Post-drilling	2.531	**-0.002**
2			**2**			**2**		
Pre-drilling	2.553	**Change:**	Pre-drilling	2.610	**Change:**	Pre-drilling	2.613	**Change:**
Post-drilling	2.562	**0.009**	Post-drilling	2.627	**0.017**	Post-drilling	2.615	**0.002**
Ball	**Low I**		**Ball**	**High I**		**Ball**	**Med I**	
1			**1**			**1**		
Pre-drilling	93.469	**Change:**	Pre-drilling	97.659	**Change:**	Pre-drilling	97.428	**Change:**
Post-drilling	90.711	**-2.758**	Post-drilling	95.355	**-2.304**	Post-drilling	94.133	**-3.296**
2			**2**			**2**		
Pre-drilling	99.560	**Change:**	Pre-drilling	104.055	**Change:**	Pre-drilling	104.294	**Change:**
Post-drilling	97.368	**-2.192**	Post-drilling	102.343	**-1.712**	Post-drilling	101.444	**-2.850**

ENGINEERING REPORT

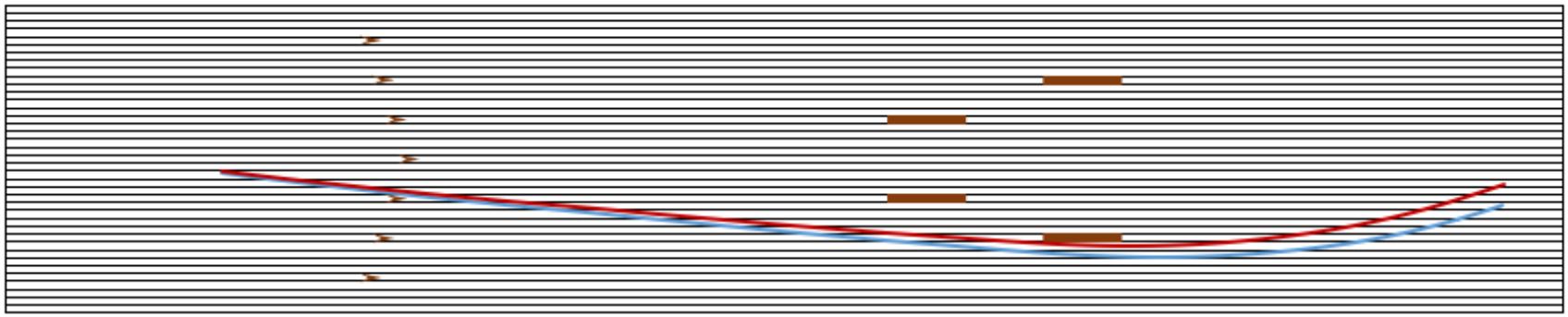




ENGINEERING REPORT



Masters Pattern Ball 1 Predrilling Masters Pattern Ball 1 Postdrilling



Masters Pattern Ball 2 Predrilling Masters Pattern Ball 2 Postdrilling