Average Deflection Force and Paddle Performance

Summary

The Average Deflection Force (ADF) test is a method by which the stiffness of a paddle face and its core can be determined. ADF values are utilized during the paddle certification process to determine the side of a paddle to be tested for spin and paddle-ball coefficient of restitution (PBCOR). The ADF test is also used on-site at professional-level tournament venues as an indirect performance metric to ensure paddles remain compliant with the specified performance ceiling.

Overview

Paddle performance, as measured by hitting power or PBCOR, is primarily a function of the paddle/ball impact interaction. Given the ball's highly inelastic deformation characteristics, the paddle's mostly elastic response is the key driver of performance. As such, it is reasonable to assume that a measurement that characterizes the paddle's elastic response will also be closely related to paddle performance. ADF is this measurement.

Distilled to its most basic form, ADF is a measure of the stiffness of a paddle's hitting area, and it is an effective representation of the hitting area's elastic response. As it relates to performance, the lower the stiffness the higher the performance. The reason for this can be explained by further considering the ball/paddle impact. In this impact, the ball deformation is highly inelastic (which means it loses energy) while the paddle deformation is highly elastic (which means it stores and returns energy). One way to optimize the paddle/ball impact is to minimize the inelastic ball deformation and maximize the elastic paddle deformation – this can be achieved by making the hitting area of the paddle less stiff.

Detailed Analysis

While the correlation between paddle stiffness and performance is relatively straight forward, developing a single method to measure and compare the stiffness of the hitting area of all paddles is less trivial. The primary challenge to developing a suitable test method is that paddles have varying physical dimensions and core constructions and no single test setup perfectly accounts for all paddle shapes and construction characteristics.

The current test method utilized for ADF testing consists of supporting the paddle face on a pair of 4.0” long, 0.50” diameter steel rods centered under the paddle face. The rods are spaced 6.0” apart, center to center. This setup is shown in Figure 1.

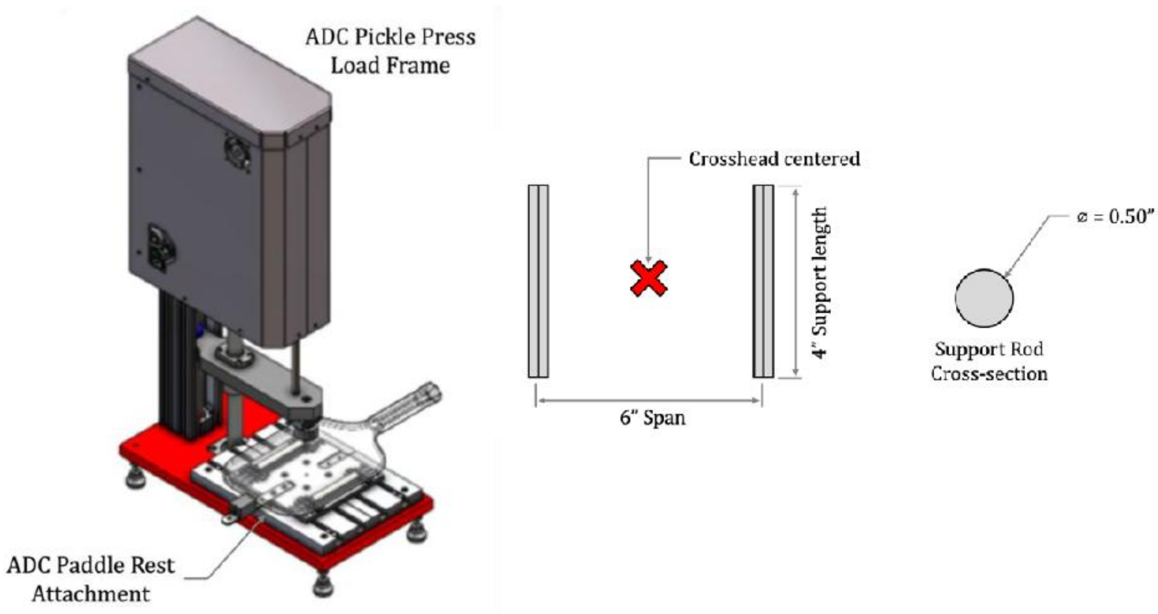

Figure 1

This setup results in a stiffness measurement that accounts for a combination of the hitting area’s flexural and compressive stiffnesses and it allows for multiple locations in the paddle’s hitting area to be tested.

The correlation between ADF values collected using this test setup and paddle performance is imperfect but very strong, trend-wise. This means that the effectiveness of using ADF to predict or qualify performance depends on the user’s goals and expectations. If ADF is used in a conservative manner to compare paddles and screen out paddles whose performance is very likely beyond the specified limit, ADF-based screening can be very effective. However, if the goal of ADF testing is to screen out each and every paddle as soon as that paddle is likely to exceed the performance limit, then the currently described ADF test will be far less effective.

ADF Refinements

In order to utilize ADF screening to more precisely pinpoint when each and every paddle is likely to exceed the performance limit, adjustments to the testing process would be required. Such adjustments could include, but would not be limited to paddle support conditions, compression depth and compression location.

As a first step in implementing a refined ADF process, it would be straight forward to group paddles by key characteristics and construction type and establish ADF parameters for each grouping. Screening paddles with group-specific ADF parameters would improve the precision of the screening process but the ADF-performance correlation still may not be precise enough if the goal is to screen out every paddle that may be out of compliance.

To further improve the ADF-performance correlation the ADF process can be further refined by adjusting the testing parameters for each paddle model. By tailoring the process to each individual paddle model, cross-model correlation error can be eliminated and the resulting ADF-performance correlation will be as accurate as possible. In this scenario each paddle model's ADF value can be used as a performance fingerprint or signature value.

While there are few technical limitations to implementing refined ADF processes, it is appreciated that constructing fair and equitable rules around the use of such refined processes may be more challenging.

Future Considerations and Additional Thoughts

In its current form and current applications, ADF remains an effective tool. As paddle technologies and on-site testing needs continue to evolve it will be fair to reconsider whether ADF should be applied differently, or at all. Given that it has been shown that ADF can be adapted to fit a wide range of needs, it is anticipated that it will continue to be an effective tool into the future.

Finally, it is worth noting that as the PBCOR certification process is implemented, the reliance on ADF will likely be minimized. This is because under current market conditions, most paddles already exist on the market and are certified without the use of a true and universal performance threshold. The lack of a common performance threshold that is correlated with ADF means that ADF screening can only be reasonably applied as a way to compare all paddles and remove those whose performance is an outlier to the rest of the market. Based on the need to compare ADF values across all paddles, the ADF process must be applied as equally to all paddles as possible (ie – using the same test setup and parameters).

As soon as PBCOR certification begins, there will be a universal performance threshold that correlates with ADF and it will become feasible to implement ADF screening in a way that might be more preferred by the market. For example, if it is desirable to establish paddle model-specific ADF values based on when each paddle model is likely to exceed the established performance limit, it will be feasible to do so, even though the need for this will likely be minimized because paddles which are likely to exceed the established performance limit will be prevented from entering the market based on the initial certification process.